49

AD689102

HUDSON LABORATORIES of Columbia University

145 Palisade Street, Dobbs Ferry, N. Y. 10522

TECHNICAL REPORT No. 155

PRELIMINARY DESIGN CONSIDERATIONS FOR THE CATAMARAN RESEARCH VESSEL T-AGOR-16

by

Henry C. Beck and Andrew Gonda

September 1968

Contract Nonr-266(84)

224

CU-183-68-ONR-266-Phys.

Hudson Laboratories
of
Columbia University
Dobbs Ferry, New York 10522

Technical Report No. 155

PRELIMINARY DESIGN CONSIDERATIONS FOR THE CATAMARAN RESEARCH VESSEL T-AGOR-16

by

Henry C. Beck and Andrew Gonda

UNCLASSIFIED

September 1968

Document cleared for public release and sale;
its distribution is unlimited.

This report consists of 197 pages

Copy No.
of 145 copies

This work was supported by the Office of Naval Research under Contract Nonr-266(84). Reproduction in whole or in part is permitted for any purpose of the United States Government.

ABSTRACT

A history of ship usage at Hudson Laboratories is presented. Experience derived from this usage, from the conversion of the USNS GIBBS to a research vessel, as well as from preliminary plans for the conversion of the USS TERROR to a research vessel, is described as it relates to the preliminary design of the T-AGOR-16. A discussion of the preliminary design of the catamaran research vessel and its equipage is presented and terminates with the development of the building specifications. Originally intended for use by Hudson Laboratories of Columbia University, the subject vessel is now to be used by the Naval Research Laboratories. In discussing its mission, Hudson Laboratories oriented programs are stressed. Changes to be made to the vessel ~~by NRL~~ to accommodate their programs are not detailed.

INDEX

		PAGES
I	Historical Review of Ship Usage at Hudson Laboratories	1
II	Search for a Conversion Hull	23
III	Conversion Plans for the USS TERROR MMF-5	31
IV	Conventional Hull Proposal by Ships Characteristics Board	42
V	Preliminary Catamaran Studies	45
VI	Comments and Problems Involved with SCB Preliminary Characteristics for the Catamaran Research Vessel	48
VII	General Arrangement of Approved Design	60
VIII	Review of Detailed Compartment Layouts, T-AGOR-16	77
IX	Mechanical Handling Gear	106
X	Scientific Electronic Equipment, Power Lighting and Communications	133
XI	Conclusions and Miscellaneous Problem Areas	142
	Acknowledgments	147
Appendix A -	Preliminary Equipment and Facilities List USS TERROR MMF-5 Conversion to an Oceanographic Research Vessel	A-1
Appendix B -	Hudson Laboratories Recommendations for Mechanical Handling Gear, Electronic, Navigation, Communications Equipment and Power Requirements for Proposed 306-Ft Long, 3200-Ton AGOR	B-1
Appendix C -	Preliminary Characteristics for Oceanographic Research Ship Catamaran Hull	C-1
Appendix D -	Preliminary List of Handling Gear Catamaran	D-1
Appendix E -	Approved Catamaran Characteristics (March 15, 1967)	E-1

I HISTORICAL REVIEW OF SHIP USAGE AT HUDSON LABORATORIES

In the earliest days at Hudson Laboratories, sea work was accomplished aboard a chartered schooner, the BLUE DOLPHIN, and aboard government vessels such as the Fish and Wildlife Service ship, GILL. Various minesweepers and other assorted craft were also used from time to time. These vessels were generally equipped with crude handling equipment, such as gypsies, booms and davits. This type of operation was satisfactory only in the orientation and training phase during the first year or two of operations at Hudson Laboratories. In time, a number of small boats became available to us on a permanent basis and were used in the Hudson River and Long Island Sound for recovery of air drop sonobuoys and for shallow water experiments. Several amphibious ducks were used to emplace listening instruments south of the Hudson field station at Fire Island.

In the summer of 1952, the USS ALLEGHENY, a 143-ft long ATA, or seagoing tug, manned by a Navy crew became available to Hudson Laboratories (Figs. 1 and 2). She had a 34-ft beam, 13-ft draft and displaced 860 tons. The after deckhouse was extended to serve as a small laboratory and the diesel towing winch was reoriented to service the side of the vessel in conjunction with an A-frame and a trolley boom. A scientific service generator was installed below decks and portable shock cord suspended generators were installed for quiet ship service. A small over-boarding crane was mounted on the fantail and a BT winch was provided. The ALLEGHENY was programmed for continuous use by Hudson Laboratories, primarily in the Caribbean, off Bermuda, and along the east coast of the United States. A great variety of experiments were conducted from this vessel and fairly complex systems were launched from her, including many bottom-anchored, vertical listening arrays, with subsurface flotation.

Fig.1 - USS ALLEGHENY (ATA-179)

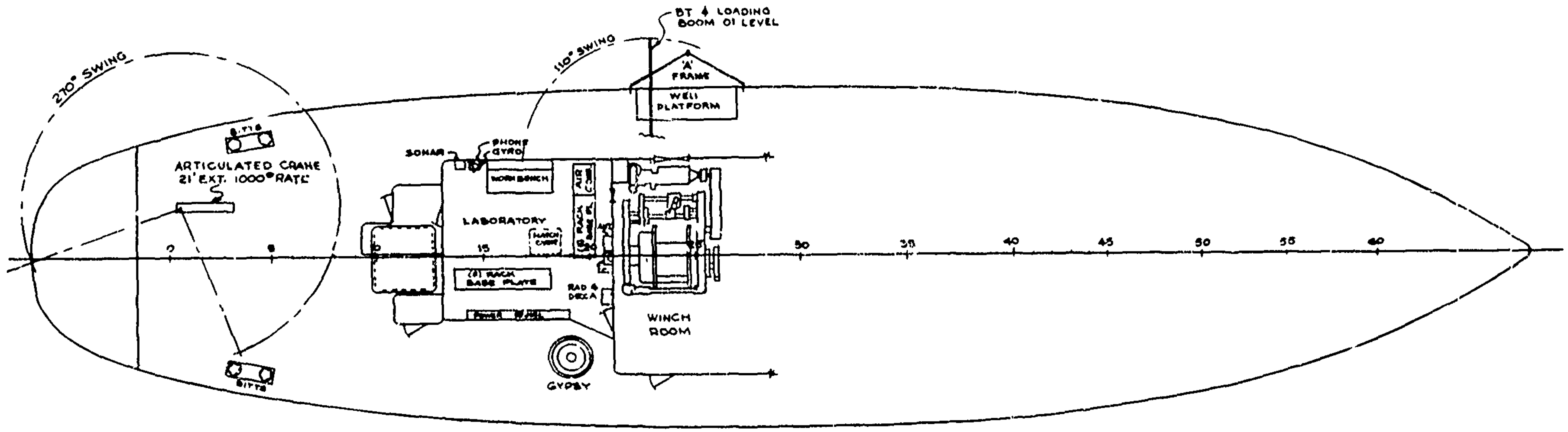


Fig. 2 - Layout -- USS ALLEGHENY (ATA-179)

Since the Laboratories devoted most of its effort to acoustic work, it was still necessary to utilize ships of opportunity in conjunction with the USS ALLEGHENY to carry out long-range acoustic experiments. It is always very difficult to establish a seagoing schedule based upon ships which are not under the operational control of the user laboratory. In time, a 65-ft steel-hulled Army transport boat, or T-Boat, was made available to the Laboratories (Fig. 3). This T-Boat, which was later named the R/V MANNING to honor an employee who was lost at sea on a small boat, was crewed by a three-man Hudson Laboratories crew. A maximum scientific party of nine could be accommodated. Initially, it participated in an experiment in the Caribbean, but generally it was used up and down the east coast of the United States and Canada up to 100 miles offshore. The Laboratories was now able to conduct long-range acoustic experiments utilizing one ship as a sound source ship and the other ship as a receiving vessel.

The limitations of the USS ALLEGHENY became apparent just a year or so after she was made available to the Laboratories. Although used exclusively as a research vessel, she was still considered to be an ATA by the Navy and we were not allowed to remove her large tripod and boom to improve her stability. Indeed, she was a critically stable vessel and we were limited as to the equipment that could be carried aboard her both by weight and moment considerations, and because of the limited laboratory space. The Navy crew numbered 40, and accommodations were available for only four to six people in the scientific party. Our experiments frequently required a greater number of people and, when embarked, they slept on cots or on matresses on the deck. In the early days of Hudson Laboratories, no sea-pay incentive was paid to seagoing personnel and only the most dedicated people volunteered for sea experiments on a regular

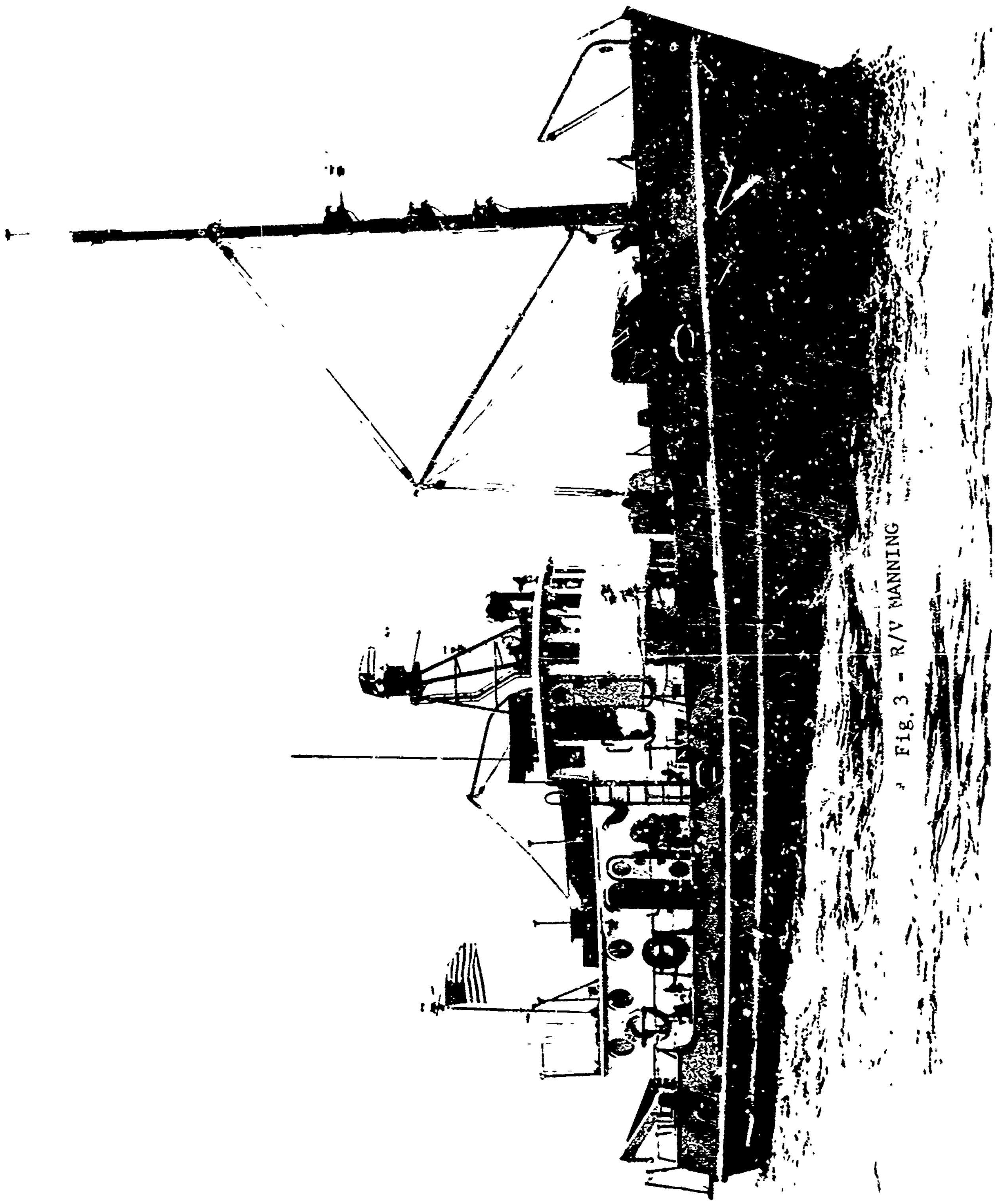


Fig. 3 - R/V MANNING

basis, particularly when the accommodations were so primitive. The diesel towing winch was limited to a working load of 7500 lb and was slow and difficult to control. The deck of the vessel was almost always awash.

A master plan was developed to improve the stability of the ship to provide additional scientific berthing and rack space, to improve the over-boarding gear, and to increase the scientific power available. This required removal of the tripod and engine room equipment which was not required for the scientific mission. Since the ship was considered to be an ATA by the Navy and participated in annual maneuvers and training, these plans were not approved. It had occurred to us to petition the Navy to change the designation of the USS ALLEGHENY from an ATA to an AGOR, but this was not palatable to the Office of Naval Research for a fiscal reason. ONR was not funding the operation of the ship since it was under the operational control of the Third Naval District. At any rate, the proposed alterations and removals would have cost a great deal of money. It appeared that this could be better spent on a more promising hull.

The T-Boat, although a seaworthy vessel, was also quite weather limited since it tended to roll quite violently. Its hold was fitted out as a laboratory, but the vessel was effectively limited to coastal waters and was equipped with minimal handling gear.

Our problems were made known to the Office of Naval Research, and we received a sympathetic ear. The TENOC program for new oceanographic vessels had not been established and we were encouraged to look for a possible conversion hull for a larger oceanographic vessel. After considerable search, the USS SAN CARLOS, an AVP or small seaplane tender was selected. This ship was 310 ft long with a 41-ft beam, a 2800-ton displacement, and a cruising speed of 15 knots.

The conversion of the ship was supervised by the Military Sea Transportation Service who eventually crewed the vessel. The firm of Designers & Planners in New York was selected for the preparation of preliminary plans and Mobile Ship Repair Corporation in Mobile, Alabama, performed the conversion. Hudson Laboratories developed the laboratory plans in conjunction with the design agent. Hudson Laboratories was concerned with MSTS operation of the vessel and it should be added that MSTS was as concerned about Hudson Laboratories, since this was the first research vessel that they had crewed. The MSTS-Hudson relationship turned out to be a rewarding arrangement for both parties.

The converted ship was named the USNS JOSIAH WILLIARD GIBBS (T-AGOR-1) (Fig. 4).[1] At the time of her conversion, it appeared to many of us that she was too large a vessel. We have since learned that any vessel which is built and completely filled with equipment upon sailing is a vessel which will prove to be too small for future use. In our case, the GIBBS turned out to be an excellent seagoing vessel, capable of working in most weather and, in general, was limited by the fragility of the systems launched rather than by the seaworthiness of the vessel itself. The crew totaled 48 men and officers and provision was made for comfortably berthing a scientific party of 26 plus four emergency berths. The crew-scientific ratio represented a tremendous advance when contrasted with the USS ALLEGHENY.

The GIBBS was converted basically as a bare ship. A major electronics laboratory capable of holding over 20 electronic racks, a smaller laboratory which could handle six racks of equipment, a radio-navigation laboratory, a mechanical engineering laboratory, a machine shop, various storage holds, data

---

[1]H. C. Beck and H. Sonnemann, Oceanographic Research Vessel T-AGOR-1 USNS GIBBS (Hudson Laboratories of Columbia University Tech. Rept. No. 81, August 31, 1959).

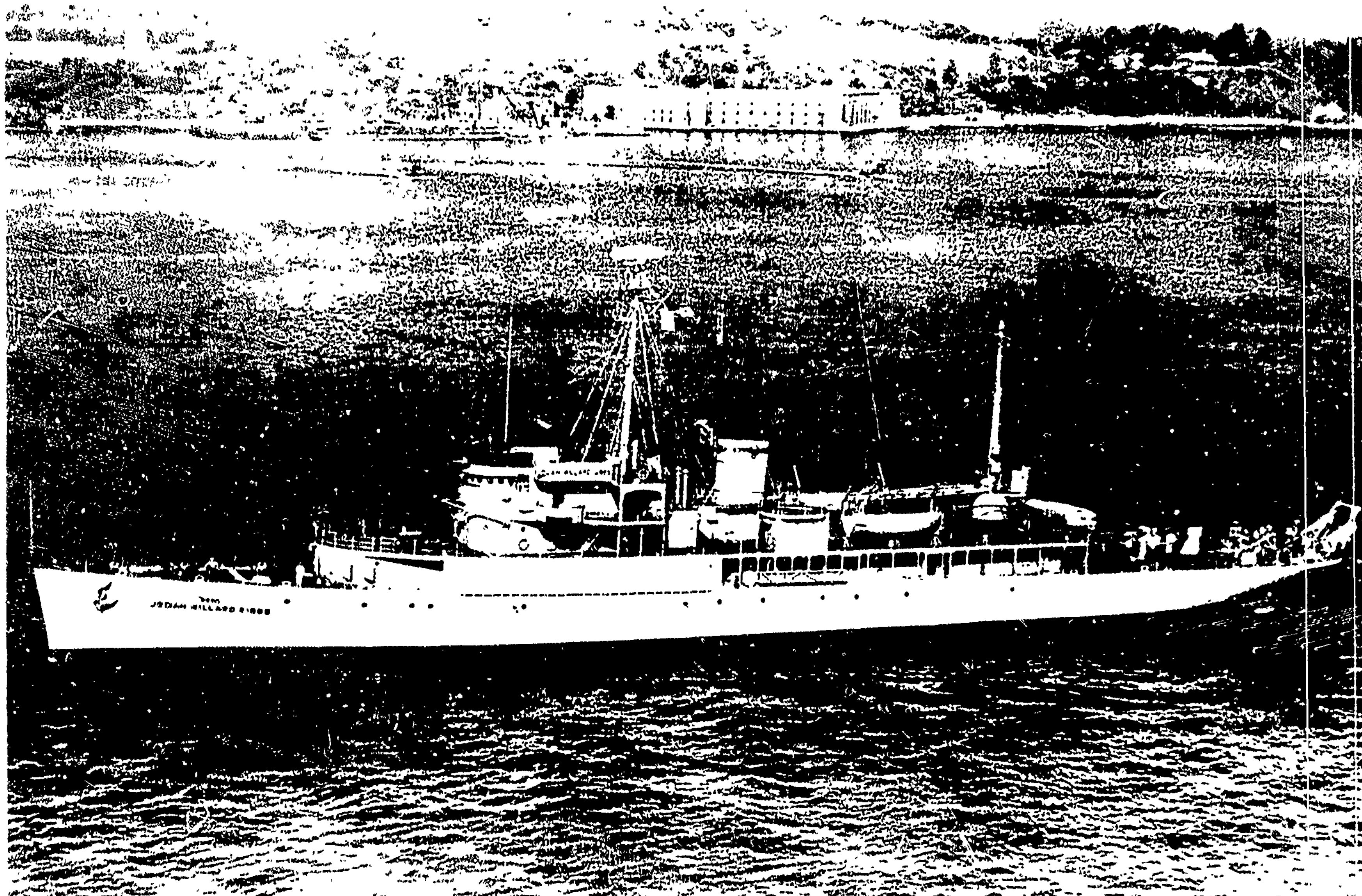


Fig.4 - USNS JOSIAH WILLARD GIBBS T-AGOR-1

processing areas, a photo laboratory, etc., were provided. Because of the short notice involved, only one winch was procured for the ship. This was an existing winch driven by an experimental motor which had been developed for the Navy, but had not been utilized by them. A stern U-frame was built and installed by the conversion yard. The ship had a 20,000-lb, 30-ft long crane.

It took many years to equip this vessel with scientific handling gear.[2] In 1959 ONR was approached with a set of specifications for a deep-sea winch. Scripps Institution was looking for a similar unit at this time. The Bureau of Ships let a contract for two similar traction type electro-hydraulic winches, which became the precursors of the standard deep-sea coring and anchoring winches now used aboard most of the new research and survey vessels in the fleet. This winch employs a traction unit which reduces the overboard tension (a maximum of 30,000 lb) to a nominal stowage tension of 1000 to 2000 lb. The rope is then stored on one of two stowage drums below decks at this reduced tension, thereby preventing the cutting in of rope turns and reducing abrasion. The larger stowage drum is capable of storing 32,000 ft of 5/8-in. diameter rope and the smaller drum 22,000 ft of the same rope. Although this winch required considerable debugging by Hudson Laboratories field personnel, it has proved to be the backbone of our handling gear complex.

Techniques for deep anchoring the GIBBS utilizing this winch were developed at Hudson Laboratories, and the ship was subsequently anchored successfully over 90 times in deep water.[3-5] In many ways, deep anchoring revolutionized the

[2] H. C. Beck and A. Gonda, Outfitting of the USNS J.W. GIBBS, T-AGOR-1 (HL Tech. Rept. No. 157, in preparation).

[3] H. C. Beck, Proposal for Anchoring the USNS GIBBS in Water Depths up to 20,000 ft (HL Tech. Memo. No. 42, April 20, 1960).

[4] H. C. Beck and J. O. Ess, Deep-Sea Anchoring (HL Tech. Rept. No. 98, July 16, 1962).

[5] H. C. Beck and J. O. Ess, Additional Deep-Sea Anchoring of the USNS J.W. GIBBS T-AGOR-1 (HL Tech. Rept. No. 156, September 1968).

acoustics work being carried out at the Laboratories. It was now possible to remain days or even weeks at anchor without use of propulsion equipment, utilizing shock cord hung generators for silent ship periods of operation while suspending listening arrays. Later deep-anchoring techniques utilized armored cables at the anchor end of which a subsurface buoyed vertical array was affixed, effectively divorcing these arrays from surface wave action and from ship noise.[6]

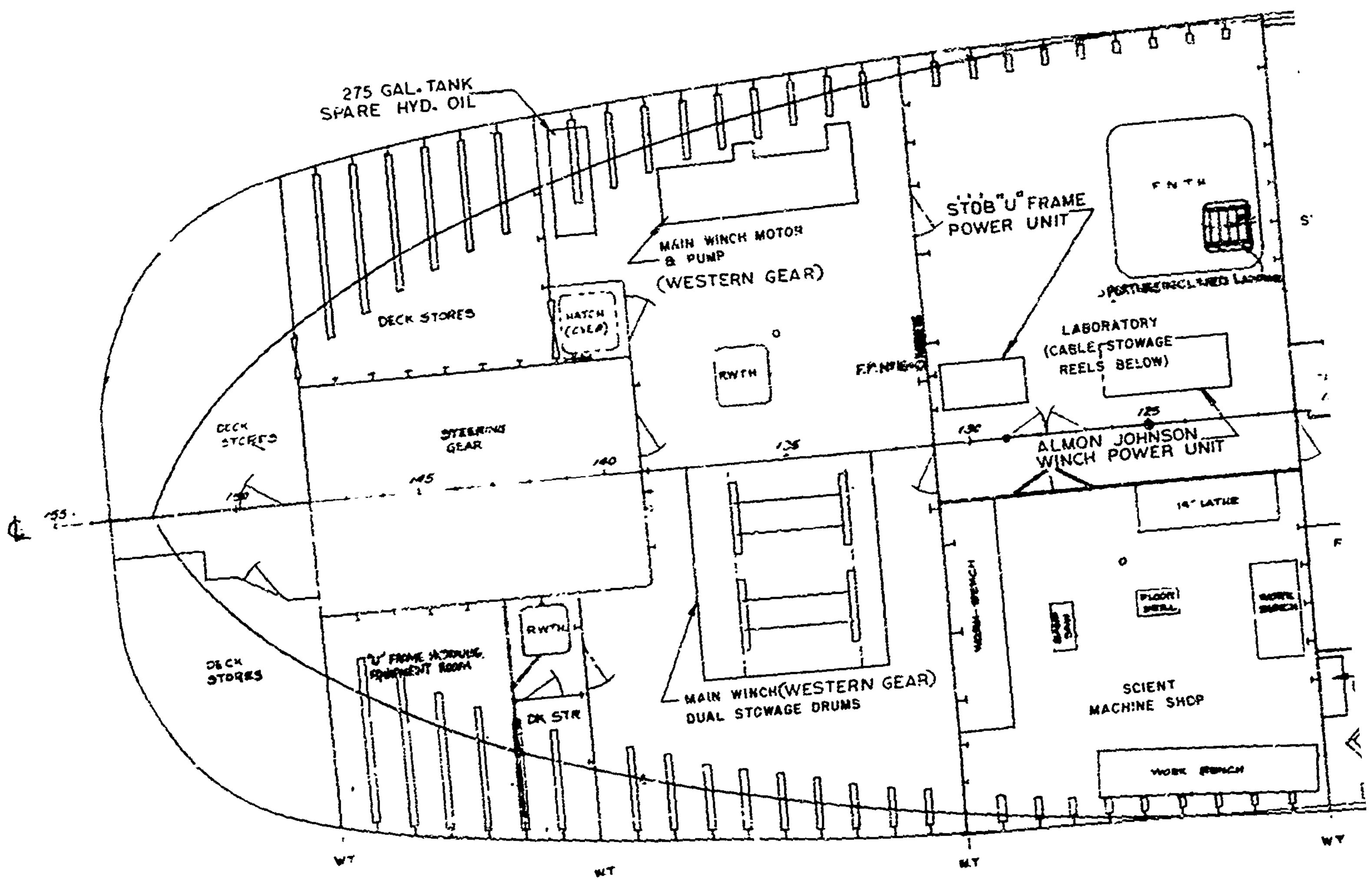
Other auxiliary winches were added to the vessel as well as hydraulic A-frames, laboratory air conditioners, etc. Since funds for this equipment became available slowly, a good deal of the engineering construction and installation work was done by Hudson Laboratories personnel. Figures 5 and 6 show layouts of the GIBBS after she was equipped.

The most modern communications equipment was installed aboard the GIBBS including single side-band radios. These were utilized by the scientific party, who maintain their own radio operations during experiments to communicate with other ships and shore stations as well as the Laboratories in Dobbs Ferry and field stations. Radio telemetry equipment was installed for use with acoustic array system buoys, etc. Loran A, Loran C and Decca navigation were provided.

A right-angle drive auxiliary propulsion unit was added to the GIBBS back aft for slow speed creep propulsion and to assist in maneuvering the vessel. The location of the unit was unfortunate. It would have been more effective installed near the bow, but the bow of this vessel is extremely fine and it would have been difficult to install this type propulsion unit far forward in the ship. Because of continuing leakage and other problems, this third propulsion unit was removed from the vessel.

---

[6]M. Lopatin and E. T. O'Neill, Twenty-Channel Vertical Listening Arrays. Part I, Electrical Features. Part II, Mechanical Features (HL Tech. Rept. No. 147, March 28, 1968).



275 GAL. TANK
SPARE HYD. OIL
MAIN WINCH MOTOR
& PUMP
(WESTERN GEAR)
STOB "U" FRAME
POWER UNIT
LABORATORY
(CABLE STOWAGE
REELS BELOW)
DECK STORES
HATCH
RWTH
STEERING
GEAR
DECK
STORES
ALMON JOHNSON
WINCH POWER UNIT
14" LATHE
"U" FRAME HYDRAULIC
EQUIPMENT ROOM
DK STR
MAIN WINCH (WESTERN GEAR)
DUAL STOWAGE DRUMS
WORK BENCH
SCIENT
MACHINE SHOP
WT

A

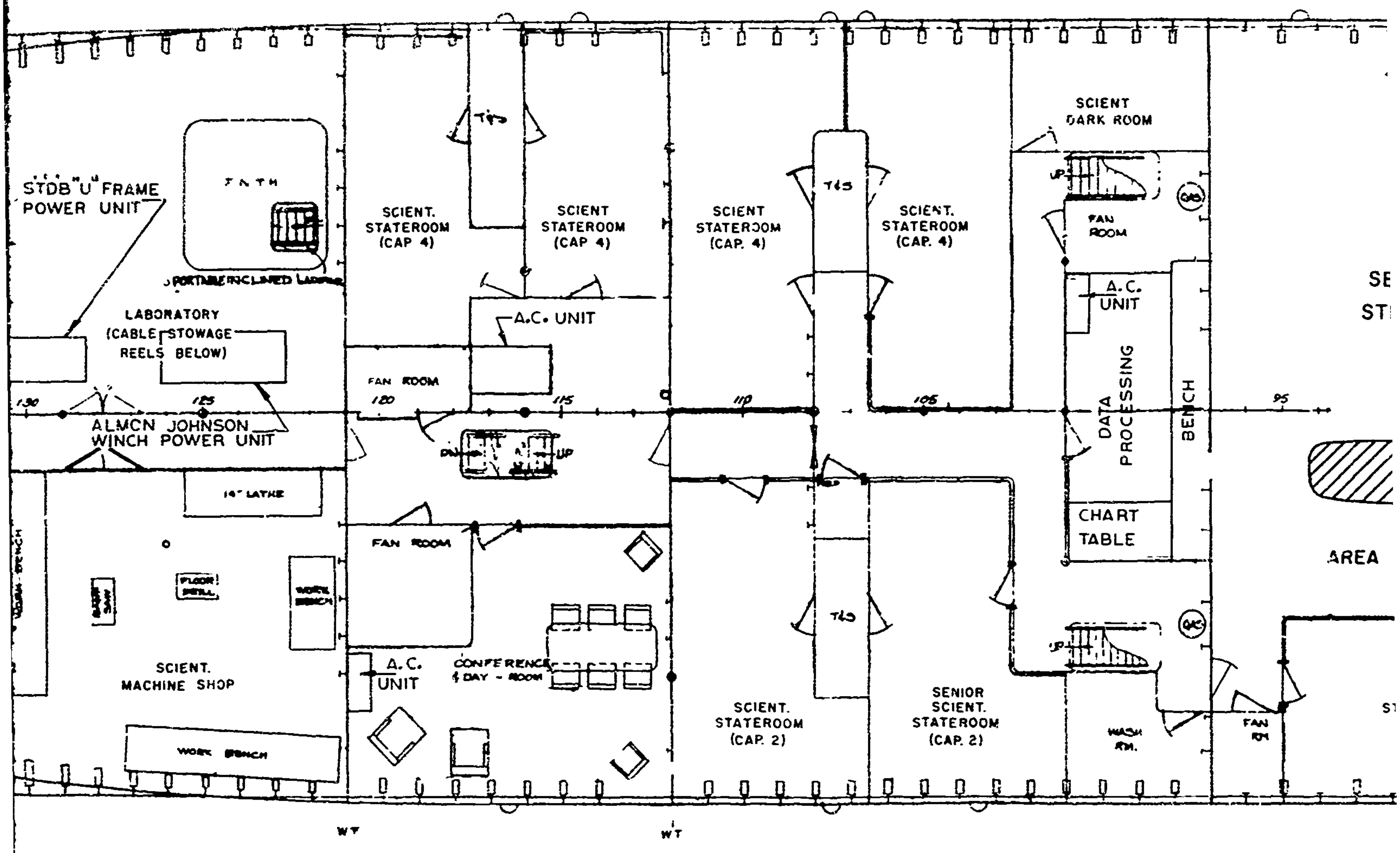


Fig. 5 - Second Deck Arrangemen

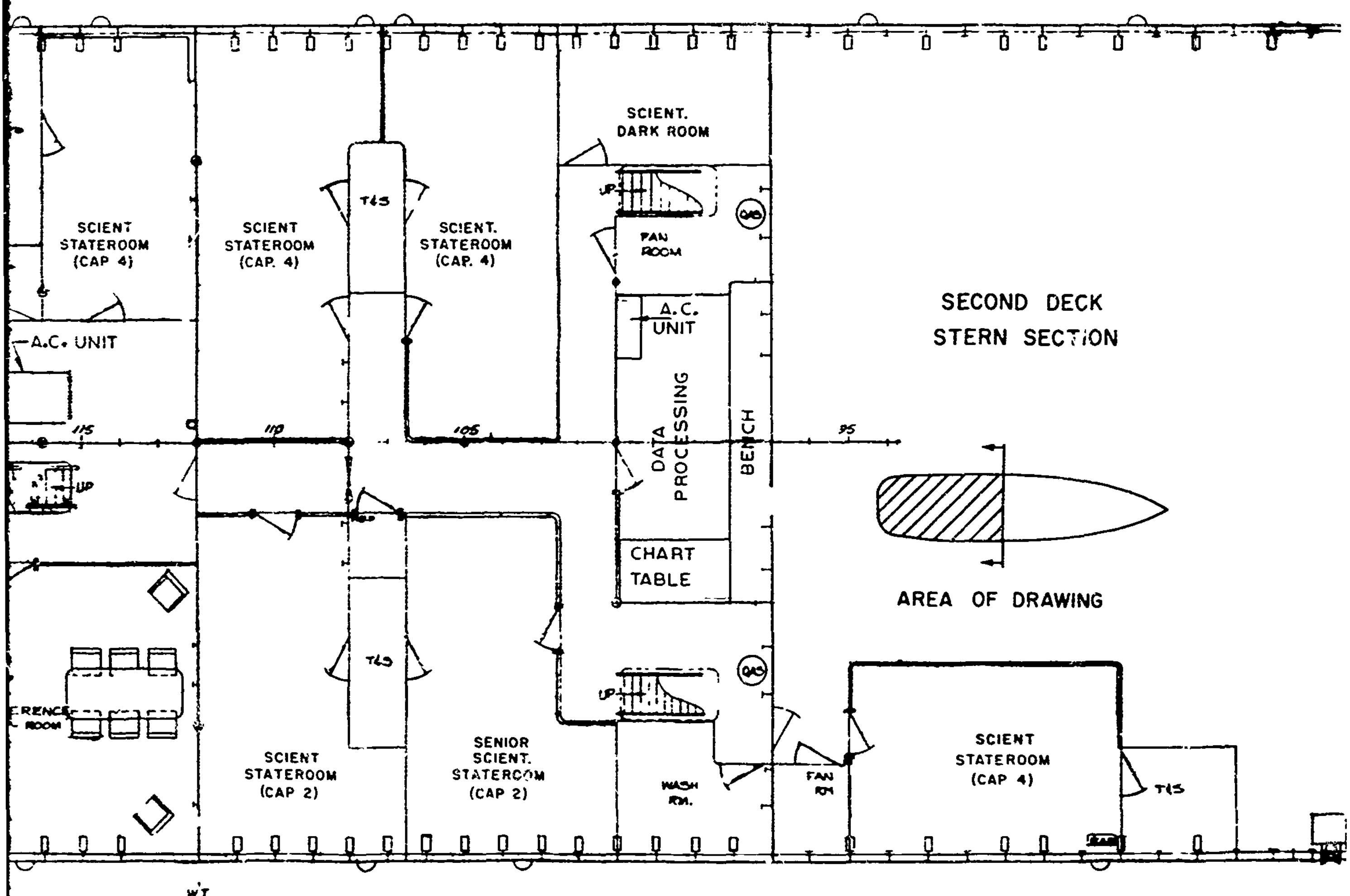


Fig. 5 - Second Deck Arrangement - USNS J.W. GIBBS T-AGOR-1

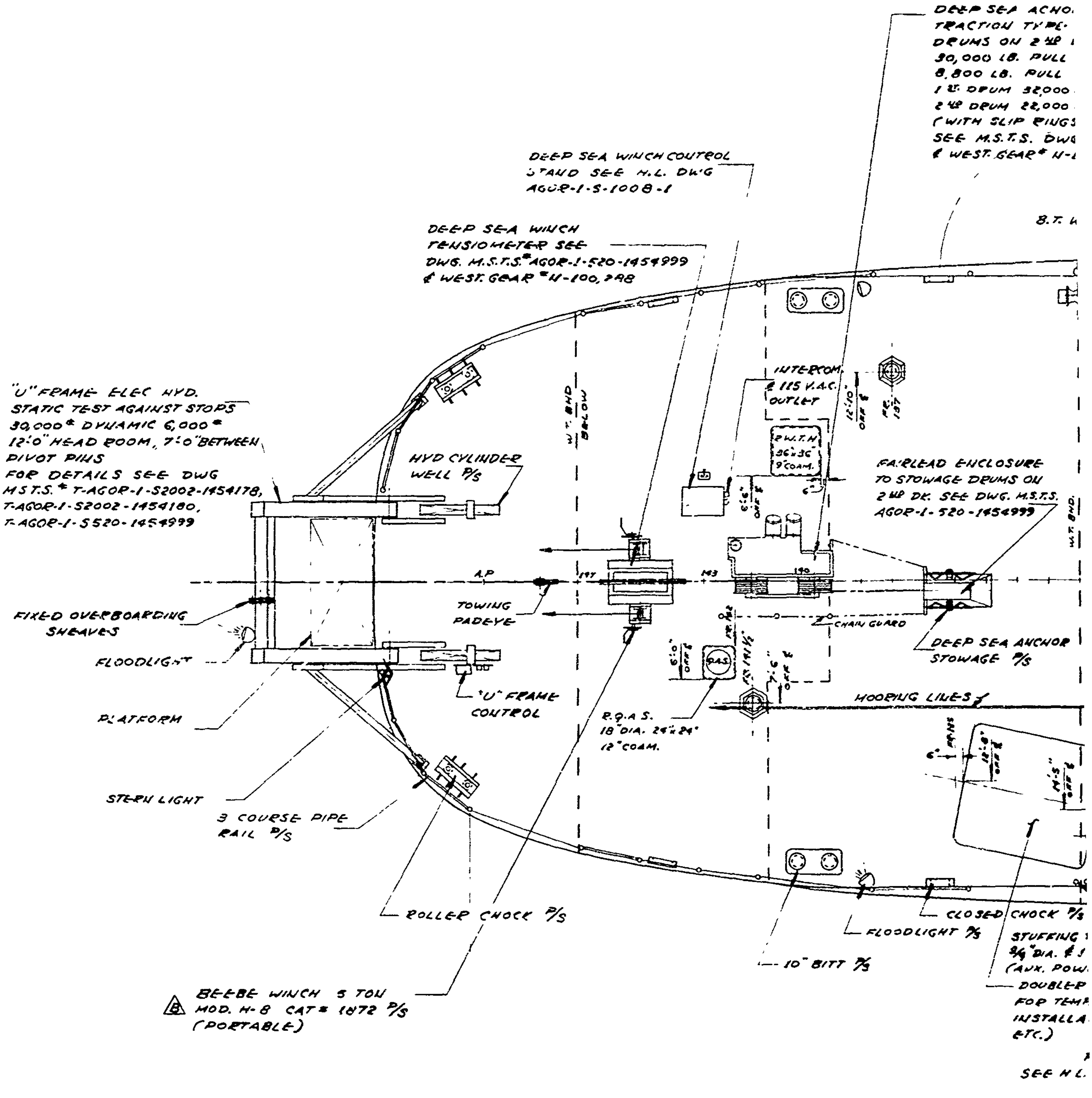
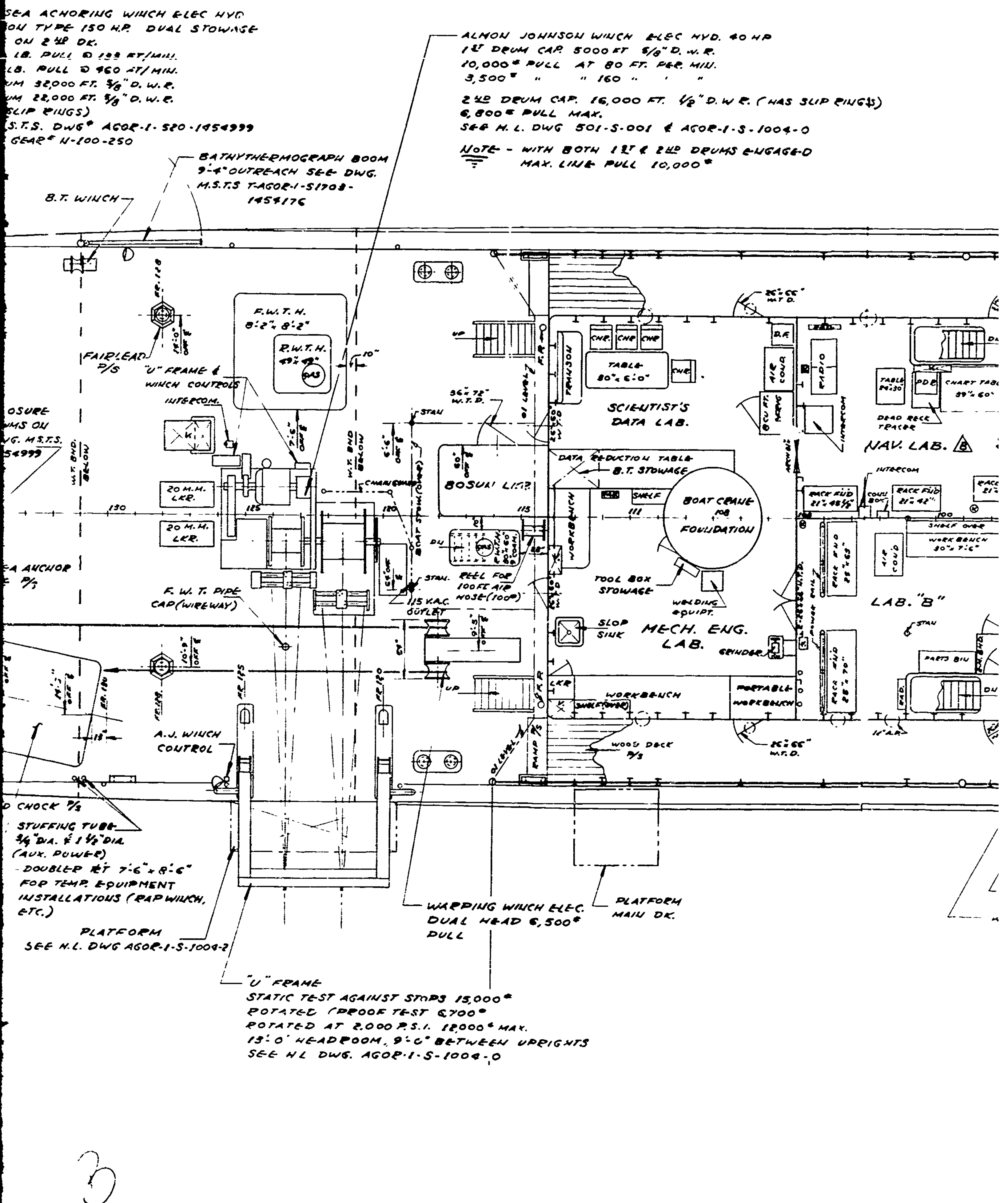


Fig. 6 - Main Deck Layout - USNS J. W. GIBBS T-AGOR-1

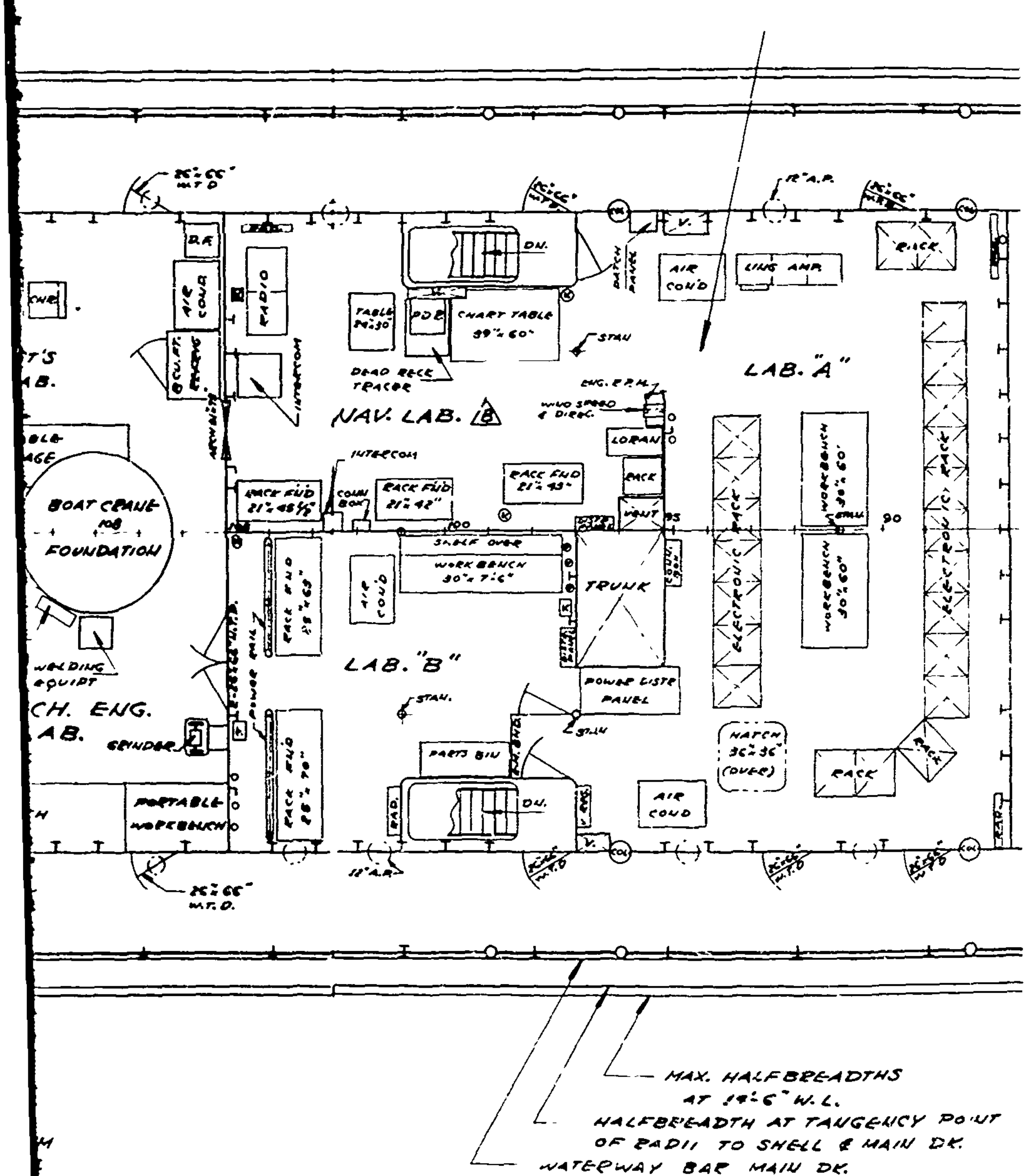

SEA ACHORING WINCH ELEC HYD
ON TYPE 150 H.P. DUAL STOWAGE
ON 2ND DK.
LB. PULL @ 133 FT/MIN.
LB. PULL @ 460 FT/MIN.
UM 32,000 FT. 5/8" D.W.R.
UM 22,000 FT. 5/8" D.W.R.
SLIP RINGS)
(S.T.S. DWG# AGOR-1-520-1454999
GEAR# N-100-250
ALMON JOHNSON WINCH ELEC HYD. 40 HP
1ST DRUM CAP. 5000 FT 5/8" D.W.R.
10,000# PULL AT 80 FT. PER. MIN.
3,500# " " 160 " " "
2ND DRUM CAP. 16,000 FT. 1/8" D.W.R. (HAS SLIP RINGS)
6,800# PULL MAX.
SEE H.L. DWG 501-S-001 & AGOR-1-S-1004-0
NOTE - WITH BOTH 1ST & 2ND DRUMS ENGAGED
MAX. LINE PULL 10,000#
BATHYTHERMOGRAPH BOOM
9'-4" OUTREACH SEE DWG.
M.S.T.S T-AGOR-1-S1703-1454176
B.T. WINCH
F.W.T.H. 8'-2" x 8'-2"
R.W.T.H.
FAIRLEAD P/S
"U" FRAME & WINCH CONTROLS
INTERCOM.
OSURE
UMS ON
VG. M.S.T.S.
54999
20 M.M. LKR.
20 M.M. LKR.
A ANCHOR
P/S
F.W.T. PIPE CAP (WIREWAY)
A.J. WINCH CONTROL
CHOCK P/S
STUFFING TUBE
3/4" DIA. & 1 1/2" DIA
(AUX. POWER)
DOUBLER PLT 7'-6" x 8'-6"
FOR TEMP. EQUIPMENT
INSTALLATIONS (RAP WINCH, ETC.)
PLATFORM
SEE H.L. DWG AGOR-1-S-1004-2
"U" FRAME
STATIC TEST AGAINST STOPS 15,000#
ROTATED (PROOF TEST 6700#
ROTATED AT 2,000 P.S.I. 12,000# MAX.
13'-0" HEADROOM, 9'-0" BETWEEN UPRIGHTS
SEE HL DWG. AGOR-1-S-1004-0
WARPING WINCH ELEC.
DUAL HEAD 6,500#
PULL
PLATFORM
MAIN DK.
BOSUN LKR
REEL FOR 100 FT AIR HOSE (100#)
115 V.A.C. OUTLET
SCIENTIST'S
DATA LAB.
TABLE 80" x 6'-0"
DATA REDUCTION TABLE
B.T. STOWAGE
BOAT CRANE FOUNDATION
TOOL BOX STOWAGE
WELDING EQUIPT.
SLOP SINK
MECH. ENG.
LAB.
GRINDER
WORKBENCH
PORTABLE WORKBENCH
WOOD DECK P/S
NAV. LAB.
CHART TABLE
DEAD RECK TRACER
INTERCOM
LAB. "B"
PARTS BIN
WORKBENCH 30" x 7'-6"
SHELF OVER
26" x 66" W.T.D.
3

EC HYD. 40 H.P
D. W. R.
ER. MIN

1/2" D W R. (HAS SLIP RINGS)

AGOR-1-3-1004-0

HD DRUMS ENGAGED
,000 #



The entire cost of the conversion and outfitting of the GIBBS was approximately two million dollars and it continues to be an extremely useful and serviceable vessel. However, since most of the Laboratories' operations required two ships and as the USS ALLEGHENY frequently could not carry out its mission because of rough weather, this resulted in the GIBBS' time being wasted and the Laboratories continued to rely upon borrowed vessels for reliable two-ship experiments. The TENOC program began producing new AGORs which were considerably better than the USS ALLEGHENY, but we felt in our judgment that they were too small and too limited in useful space as well as in seaworthiness. Hudson Laboratories was scheduled to receive a vessel under the TENOC program in fiscal year 1967. In April 1963, we informed ONR of our space and facility requirements. In effect, we requested a twin screw vessel similar in configuration to the USNS GIBBS, but with double the laboratory space and open deck working areas at least as spacious as aboard the GIBBS.

We reviewed the plans for the USNS SILAS BENT, AGS-26 (Fig. 7) with great interest. A comparison of areas and facilities is tabulated on the following pages:

COMPARISON OF USNS GIBBS (T-AGOR-1) & USNS SILAS BENT (AGS-26)

ITEM	USNS GIBBS	USNS SILAS BENT
Date constructed	1943 AVP-51 San Carlos	1965
Conversion or new	Converted Dec. 1958 to AGOR-1	New
Dimensions:		
Length overall	310 ft - 9 in. molded main deck	282 ft - 11 1/2 in. excluding bulwark
Between perpendiculars	300 ft - 0 in.	265 ft - 0 in.
Beam molded	41 ft - 0 in.	48 ft - 0 in.
Draft (design-mean)	14 ft - 0 in.	15 ft - 0 in.
Freeboard	10 ft - 9 in.	10 ft - 4 1/2 in.
Depth (main deck at side)	24 ft - 3 in.	24 ft - 11 in. (at Sta. 10)
Displacement:		
At design draft (L. ton)		
Full load	2800	2596
Speed knots:		
Cruising	15	12
Maximum	18	15
Endurance:		
Range	8000 (n.m.)	12,000 (n.m. at 12 knots)

ITEM	USNS GIBBS	USNS SILAS BENT	
Accommodation:		Listed in spec.	Listed on plans
Scientists	24 + 6 temporary	20 + 4 temp.	34
Officers	14	10	12
Crew	34	20	29 + 3 temp.
Total	72	50	75
Machinery:		Main engine	Bow propulsion
Propulsion	Geared diesels	Diesel elec.	350 hp elec.
Number	4	1 direct current double armature propulsion motor. 2 diesel driven generators.	
Shaft hp (total cont.)	6080 hp	3000 shaft hp	
Propellers:			Bow propulsion
Number	2	1	1
Type	Fixed	Fixed	Fixed pitch 360^{o} unit rotation
rpm	270	200	
Rudders:			
Number	1	1	
Machinery auxiliary:			
Ships service	2 - 200 KW, 440 V 3Ø ac diesel generators 2 - 100 KW, 440 V 3Ø ac diesel generators 2 - 35 KW, 125 V dc diesel generators 1 - 25 KW, 220 V dc motor generator 2 - 25 KW, 440 V 3Ø ac diesel generators - shock cord hung (silent ship)	3 - 300 KW, 450 V 3Ø ac diesel generators (standby ship service) 1 - 300 KW, 450 V 3Ø ac gas turbine generator (emergency lighting) 1 - 5 KW, 120 V 1Ø diesel generator (ultra quiet ship gen.) 1 - 40 KW, 450 V 3Ø ac diesel generator - shock cord supported	

ITEM	USNS GIBBS	USNS SILAS BENT
Boats	2 - 24 ft lifeboats one motor propelled - 37-man capacity one oar propelled 40-man capacity 1 - 24 ft motor workboat (carried when needed)	2 - 22 ft lifeboats 25-man capacity oar propelled alum. boat 2 - 26 ft utility boats diesel driven - plastic hull
Open deck area for scientific use: Total	 6600 sq ft	 3650 sq ft
Laboratories, shops & stowage - sq ft	Electronic labs & shop 842 Navigation lab 260 Mechanical lab 235 Library & conference room 450 Data lab 120 Dark room 80 Machine shop 340 Total sq ft labs & shops 2327	Electronic lab 210 Electronic recording lab 500 Drafting room 520 Wet lab 540 Dry lab 520 Photo finishing room and dark room 84 Reproduction room 84 Scientific office 330 Survey control center 300 Meteorological room 200 General workshop (mach.) 500 Total sq ft labs & shops 4088
	Winch room & cable stowage 1200 Other stowage 1020 Total sq ft stowage 2220	Deep sea anchor winch & storage (forward) 510 Anchor winch room aft 1000 Deep sea gear stowage aft 570 Scientific store room 320 Battery room 140 Total sq ft stowage 2540
	Magazine (5-ton capacity) plus portable magazines abt. 200	Demolition charge mag. (50 ton) 400 Rocket magazine (1 1/2 ton) 200 Total sq ft magazine 600

ITEM	USNS GIBBS	USNS SILAS BENT
Deck area for scientists:	24 Scientists	34 Scientists
Labs & shop	94 sq ft per man	120 sq ft per man
Stowage	93 sq ft per man	75 sq ft per man
Open Deck	275 sq ft per man	107 sq ft per man
Total	462 sq ft per man	302 sq ft per man
Winches & handling equipment - type, number, drive, pull, drum & capacity	Deep sea anchoring - elec. hydr. Traction type - 1 1/4 in. grooves - 150 hp - dual stowage drum 30,000 lb pull @ 133 ft/min 8800 lb pull @ 460 ft/min 1st drum - 32,000 ft 5/8" dia. rope capacity 2nd drum - 22,000 ft 5/8" dia. rope capacity - has slip rings After auxiliary winch - elec. hydraulic - 40 hp 10,000 lb pull @ 80 ft/min 3500 lb pull @ 160 ft/min Maximum light line speed 640 ft/min 1st drum - 5000 ft 1/2" dia. rope capacity 2nd drum - 16,000 ft 1/2" dia. rope capacity slip rings Forward auxiliary winch - elec. hydraulic - 10,000 lb pull @ 75 ft/min 5000 lb pull @ 150 ft/min 2 drums - each 20,000 ft 1/2" dia. rope capacity and slip rings Hydro winch - elec. hydraulic 15 hp 1000 lb pull @ 450 ft/min 1500 lb pull maximum 35,000 ft 5/32" dia. rope capacity	Hydro winch (2) - elec. hydr. 1 drum 2000 lb pull @ 350 ft/min 1000 lb pull @ 630 ft/min 30,000 ft 3/16" dia. rope capacity Stowage & inspection winch - elec. - drum interchangeable with hydro winch drum 1500 lb pull @ 300 & 75 ft/min 30,000 ft 3/16" dia. rope capacity Magnetometer winch - elec. double drum - 600 lb @ 100 ft/min 1200 lb static (one drum at a time) 100 ft 0.70 in. dia. elec. cable, 1500 lb breaking strength B.T. winches (2) Deep sea coring winch aft (1) traction unit - 3/4" grooves 6800 lb @ 600 ft/min 30,000 lb @ 133 ft/min (2) 2-drum stowage unit - each drum 45,460 ft of tapered cable 3/8" dia. to 3/4" dia. (3) 1-drum intermediate unit - 30,000 ft 1/2" dia. rope capacity

ITEM	USNS GIBBS	USNS SILAS BENT
Winches & handling equipment - type, number, drive, pull, drum & capacity (Con't)	B.T. winch Warping winch - 1 forward, 1 aft, electric, dual heads 6500 lb pull Motorized stowage drums (2) 5 hp 20,000 ft 1/2" dia. rope capacity Crane - 20,000 lb, 30 ft outreach U-frame - elec. hyd. (stern) 30,000 lb capacity against stops - 6000 lb dynamic 12 ft headroom, 7 ft between uprights Hydraulic boom (forward) - 10,000 lb capacity & starboard platform (main deck) Fixed bow davit - 10,000 lb capacity Ammo. booms - forward 1 port, 1 starboard 1200 lb capacity with davit Hydro gate boom - 1500 lb capacity & hydro platform (main deck aft) Bow platforms (2) U-frame (aft starboard side) - hydraulic - static test against stops 15,000 lb - 6000 lb capacity when rotating	Deep sea anchoring winch - forward similar to coring winch Current meter winch - one drum elec. hyd. 400 lb. pull @ 375 ft/min 800 lb static 10,000 ft 0.2 in. dia. rope capacity Sound velocity winch Gek winch Electric winch (all identical to current meter winch) Vertical capstan elec. - 01 level 2000 lb @ 50 ft/min Vertical capstan elec. - main deck aft 5000 lb @ 40 ft/min 10,000 lb @ 20 ft/min Crane - elec. hydraulic two hoisting unit outreach 61 ft maximum, 18 ft minimum (1) 10 tons @ 50 ft/min 45 ft outreach 15 tons 35 ft outreach (2) whip 3 ton @ 100 ft/min 31 or 50 ft outreach Two speed rotation 1/2 rpm 1/8 rpm Two thermistor chain winches

ITEM	USNS GIBBS	USNS SILAS BENT
Winches & handling equipment - type, number, drive, pull, drum & capacity (Con't)		U-frame 50,000 lb - topping load to main deck (power) 6000 lb @ 3^{o} per second rotate 1/4 rpm (manually) Hydro winch davit - 01 level 4500 lb static - 2000 lb working - 2 platforms, main deck & 01 level jib crane 02 level Outrigger boom (aft - port) Elec. cable davit (aft - port) Sound velocity davit - (aft - port) Current meter davit & platform (forward & starboard) Anchor davit (bow)
Electronics	Radar, Decca, PDR, PGR, EDO, single side band & other radios, Loren A, Loran C, RDF, DRT	Radar, Loran, Radiosonde, RDF, PDR, PGR, various radio receivers & transmitters
Special features	Labs & scientific berthing air conditioned Accommodations for instrument huts & portable winches Can anchor at stern in water to 20,000 ft depth for long periods Large hatches serving all major labs & stowage area	Labs & living spaces air conditioned Can anchor at stern & bow in deep water Hatch serving deep sea gear compartment only

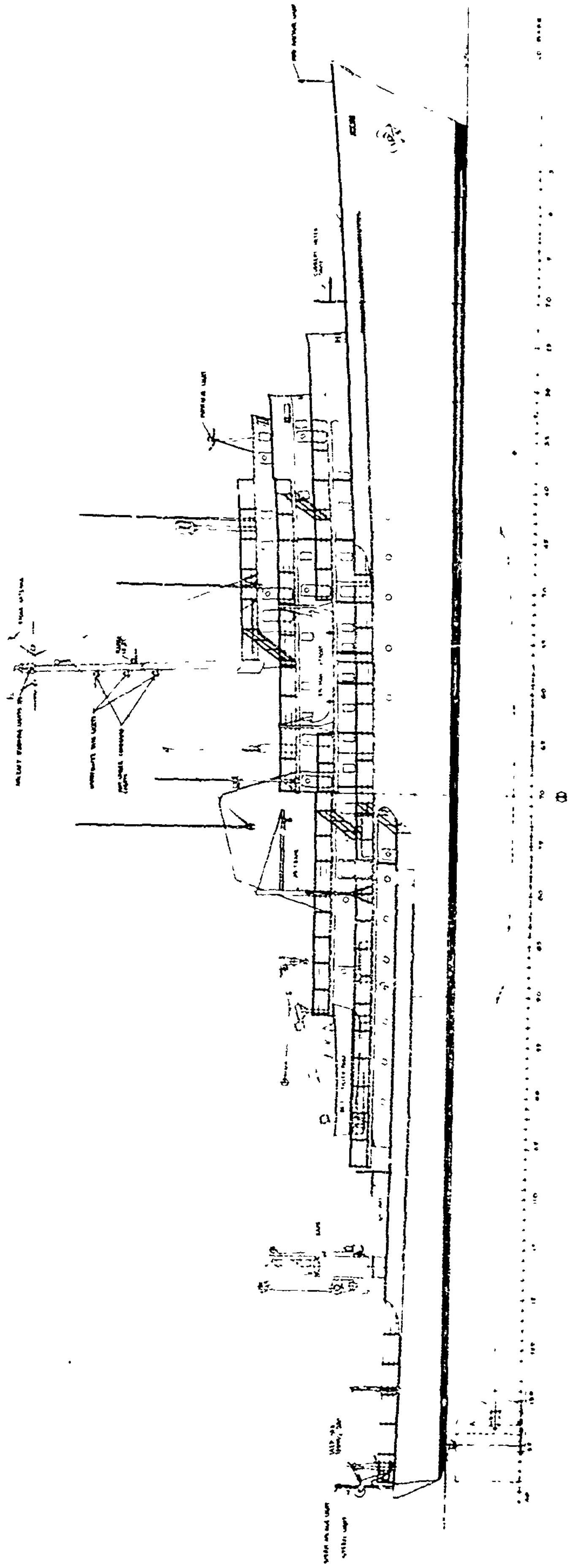
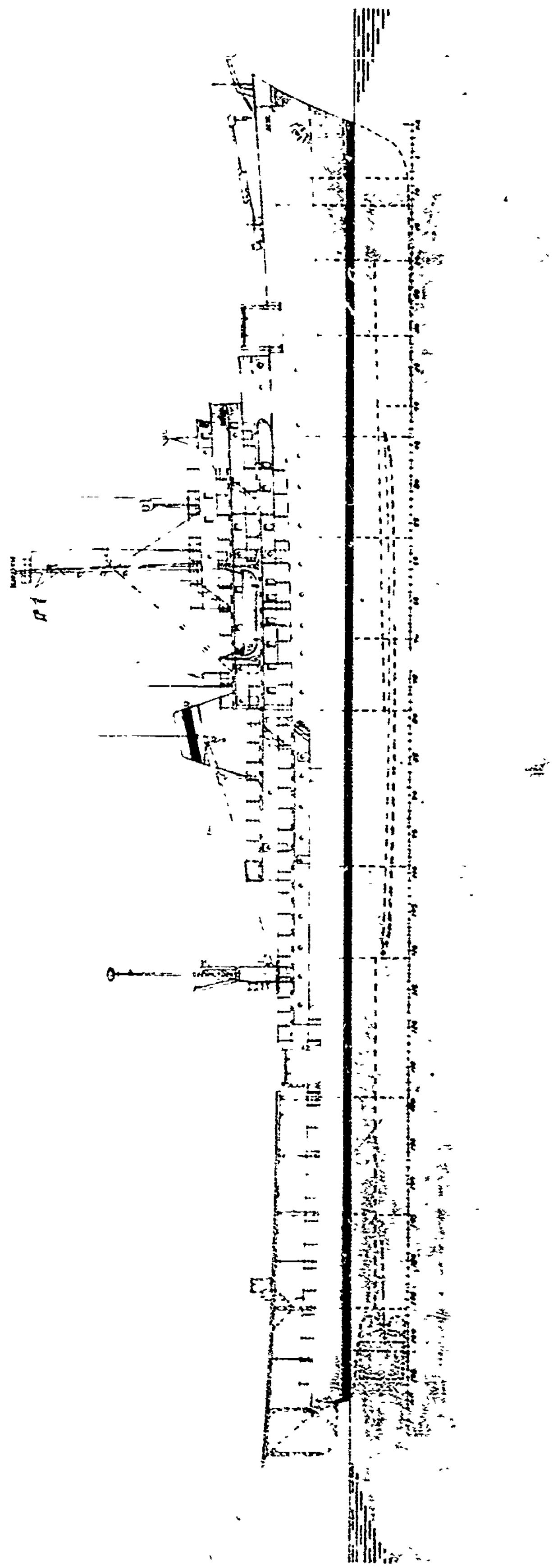


Fig. 7 - USNS SILAS BENT AGS-26

The BENT was a most impressive ship, but fell somewhat short of our requirements for laboratory space. It lacked sufficient scientific stowage space and about 25% of the space available was of limited use since it was located well below the main deck and was not served by hatches. A major drawback was the rather limited open deck area available for scientific use. The rudder was located well aft presenting a probability of damage to it or to equipment in launching. Although a single screw vessel, manueverability was provided by a bow propulsion unit. It appeared that a ship of this general configuration, perhaps extended in length some 30 ft, would fit the needs of the Laboratories admirably.

Figure 8 represents a larger AGOR proposed by Hudson Laboratories. No detailed layouts were prepared for either of these vessels, although fairly detailed equipment lists were developed. By the summer of 1965, it became obvious that it was too late to produce a new vessel by fiscal year 1967. A number of meetings were held with ONR, Scripps Institution of Oceanography and Woods Hole Oceanographic Institution to discuss the design of a new vessel. The latter two organizations were to receive follow-on vessels of the same class.

We had asked ONR if the $12,700,000 programmed for our new ship would be available for the conversion of an existing hull and found that this would be allowed. It became our avowed intent to locate, convert and equip a suitable hull at a cost well below the money available for new construction. It was hoped that any money saved could be applied to construction of a new vessel in the mid-1970's for use by Hudson Laboratories. In the meantime, the converted vessel would be available to us in 1967.



II SEARCH FOR A CONVERSION HULL

In addition to the ships mentioned previously, most modern research ships in the United States and Canada were evaluated. In many cases these ships were visited and the users were consulted to insure that we would take advantage of the latest thinking in the research field.

An exhaustive survey of existing hulls in the Maritime Administration and Navy reserve fleets was conducted. Most of the small seaplane tender hulls (AVPs) were either in service or in questionable condition. These vessels were of World War II vintage, with thin hull plating similar to that of a destroyer. The feeling at Hudson Laboratories was that an advance should be made, and a vessel offering more useful laboratory space and greater flexibility than the GIBBS should be converted.

Among the hulls examined, a C1-MAV-1 (Fig. 9) was seriously considered. One of this class of vessels had been transferred recently to the Maritime reserve fleet at Stony Point, New York. Consultation with MSTSLANT, her former operators, revealed that she was in excellent condition. A number of large air-conditioned compartments existed which were easily convertible to laboratory spaces and scientific berthing was no problem. This class of ship is approximately 338 ft long overall with a 50-ft beam and draws 21 ft of water displacing 7500 tons, full load. Most are of late World War II vintage.

MSTS had indicated the possibility that the USNS MIRFAK (T-AK-271), an Arctic replenishment vessel, might become available for conversion. The other two vessels of this class, the USNS ELTANIN (Fig. 10) and USNS MIZAR, were already operating successfully as research vessels; the former in the Antarctic

Fig. 9 - C1-MAV-1 Class

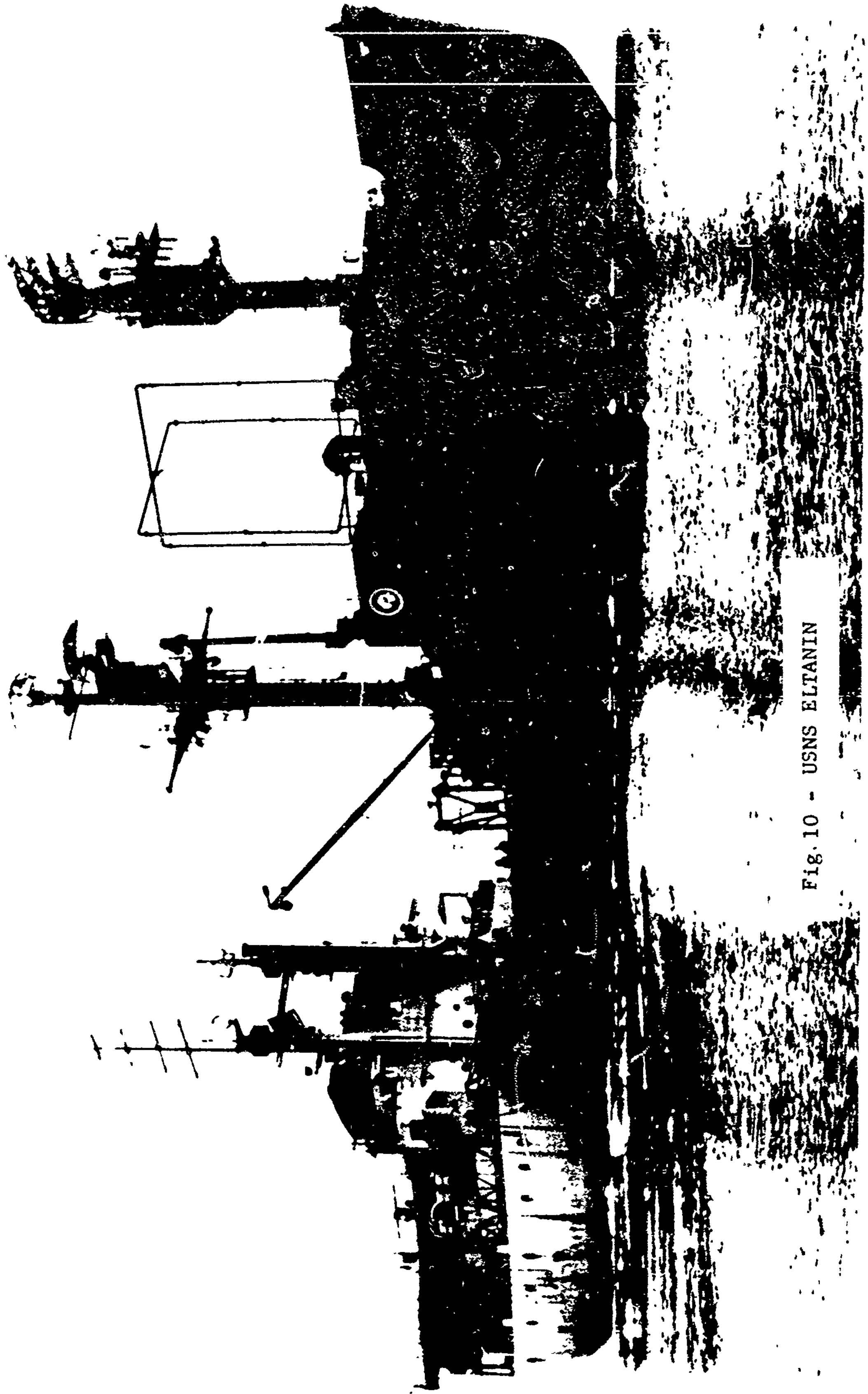


Fig. 10 - USNS ELTANIN

under National Science Foundation sponsorship and the latter for the Naval Research Laboratories. These ships were built in 1957, whereas all other vessels considered were constructed twelve to fifteen years earlier. They are approximately 262 ft long overall with a 51-ft beam and draw 18 ft 7 in. of water at their full load displacement of 4940 tons. The hulls are ice strengthened. Cruising speed is 13 knots.

The major reason neither of these classes of vessels was chosen was because of the lack of working deck space at the stern, since both ships have after deckhouses. This was not an arbitrary decision, but was one made on the basis that a stern working area was essential to carrying out the mission of Hudson Laboratories. The authors have found that oceanographic laboratories can be typified as stern launchers, side launchers and well launchers, based upon the type of work to be accomplished. In the case of Hudson Laboratories, very large sound sources, mooring buoys, and acoustic listening systems are frequently deployed. Side launching is generally avoided since the roll of the ship makes it difficult to prevent banging of the equipment on the side of the vessel. It is frequently fairly easy to launch equipment successfully using tag lines, etc., but damage generally occurs in recovery of the equipment when it is not under full control. Center wells are quite useful for handling deep suspended equipment, particularly if carriages are used which control the equipment at the sea-air interface. Center wells do restrict the geometry of equipment launched and are not useful for handling surface-streamed gear. A stern-launching area in which a number of pieces of handling gear can be used simultaneously provides a good compromise. If the ship is properly oriented, there is less ship motion relative to the water at the stern and a near infinite "well" exists for launching equipment.

Liberty, Victory, C1 and C2 hulls were inspected. The better ships were in the process of being reactivated or had already returned to service because of the conflict in Vietnam. All of these ships required considerable ballasting to reduce freeboard to the point where launching of equipment would be practical. Most of the ships had rudders set far aft which would be vulnerable to damage from stern-launched equipment. The C1-A hull (Fig. 11) is rated at 11,800 tons full load at a draft of 23 ft 7 in. It is 412 ft long overall with a 60-ft beam. Propulsion is single screw diesel and speed is 14.8 knots.

Two APAs of the C2-S1-A1 hull type (Fig. 12) were inspected. These ships are rated at 10,885 tons full load. They are 450 ft long overall with a beam of 62 ft and a maximum draft of 23 ft 6 in. They are driven by steam turbines, with a speed of 18.2 knots. Several AKAs of the C2-S-B1 class were also examined. For reasons mentioned in the previous paragraph and because of the generally poor condition of the ships, these hulls were rejected.

During a visit to the James River reserve fleet, the USS GALILEA, AKN-6 (Fig. 13) was inspected with great interest. Originally a flush-deck, cruiser-hull, net-laying ship built in 1944, this vessel was converted on several occasions to serve as a transport, landing ship vehicle and finally to a net carrier. In the process, the stern was changed from the original flush deck to the configuration shown in Fig. 13 and finally to that shown in Fig. 14. This vessel was approximately 450 ft long, with a 60-ft beam and a maximum draft of 20 ft, and a full load displacement of 9000 tons. Her propulsion was geared turbine, twin screw, 11,000 shaft hp with a speed of 20 knots. Although this vessel was considerably larger than required, its general configuration and net-handling galleries represented the most promising conversion potential of any ship seen up to that time. We immediately resolved to inspect all other ships of this type.

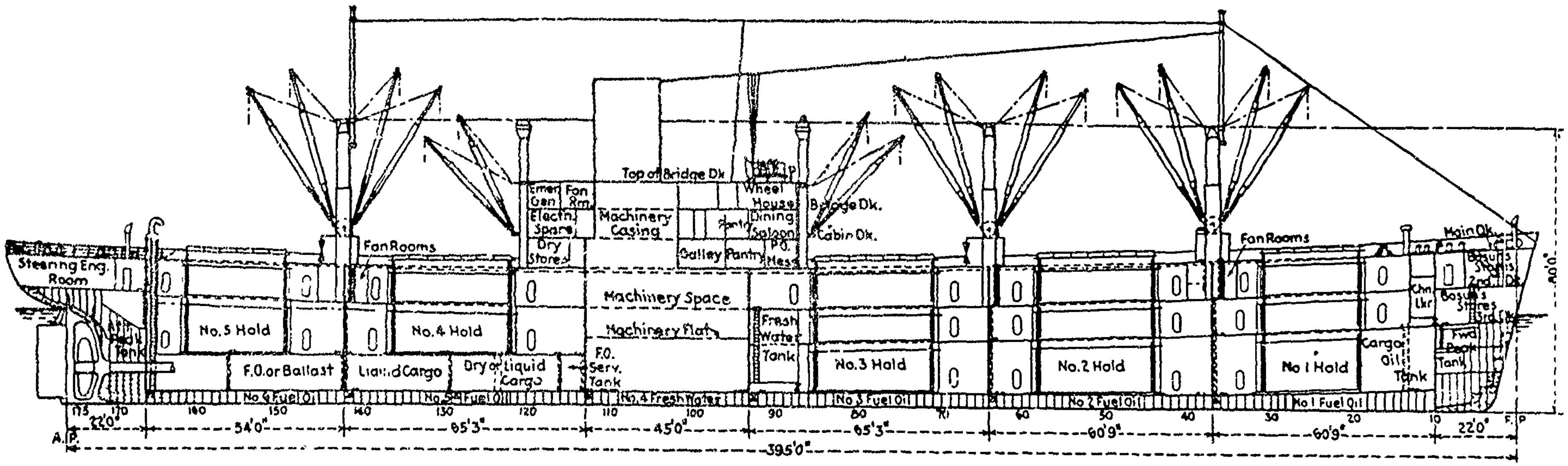


Fig. 11 - C-1 Hull

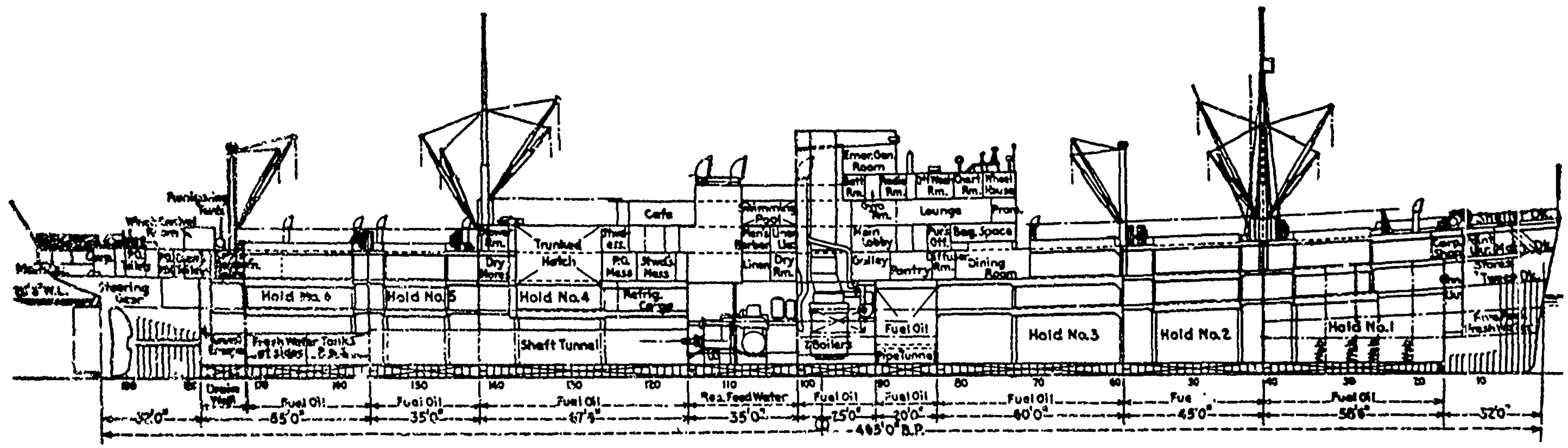
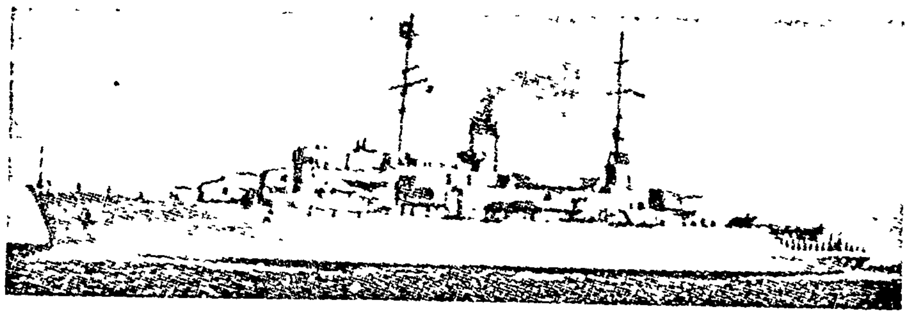


Fig. 12 - C-2 Hull



GAL!LEA 1950, courtesy Ingal.'s Shipbuilding Corp

Fig. 13 - USS GALILEA AKN-6

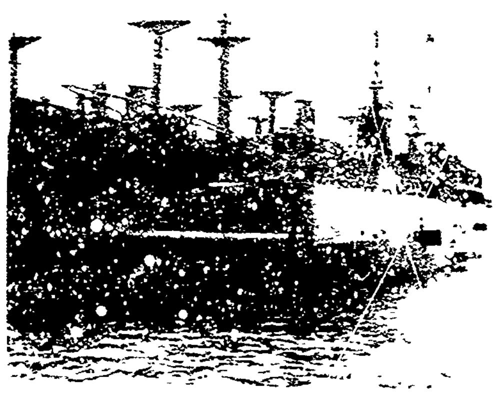


Fig. 14 - Stern of USS GALILEA AKN-6

III CONVERSION PLANS FOR THE USS TERROR MMF-5

Visits were made to reserve fleets in California and Texas, and finally to the U. S. Naval Shipyard in Philadelphia in the fall of 1965. The USS OZARK and USS CATSKILL were already in the process of reactivation. The USS MONITOR MCS-5, USS OSAGE MCS-3, USS SAUGUS MCS-4, and the USS TERROR MMF-5 were all visited. The USS TERROR (Figs. 15 and 16) was finally selected for a detailed study to determine its suitability for conversion to a research vessel. The Office of Naval Research, Bureau of Ships, and Military Sea Transportation Service as well as Hudson Laboratories participated in this study.

This ship was 453 ft long, with a 60-ft beam and a draft of 20 ft. Her cruising speed was 20 knots and her full load displacement 8630 tons. Her main propulsion plant was geared turbine, twin screw with a shaft hp of 11,000. She was built in 1942 and laid up after World War II. Her machinery was in excellent condition since she had not steamed extensively.

The USS TERROR was somewhat similar to the USNS GIBBS in general configuration. The dimensions of the former were approximately 30% larger than that of the latter in all three dimensions, providing a volume and tonnage more than three times as great. It was obvious to us that the USS TERROR would provide a great deal more usable laboratory and deck space than was requested in our earlier AGOR specifications. Commodious quarters for crew and scientific personnel were available.

A major attraction was the two large second deck mine-laying galleries which were admirably suitable for installation of handling gear and laboratory

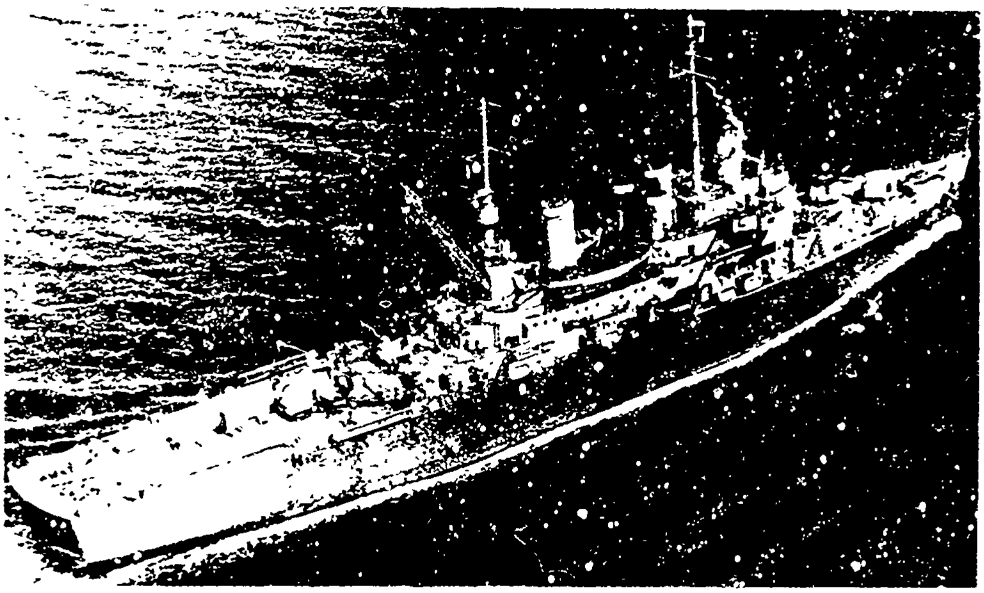


Fig. 15 - USS TERROR MMF-5

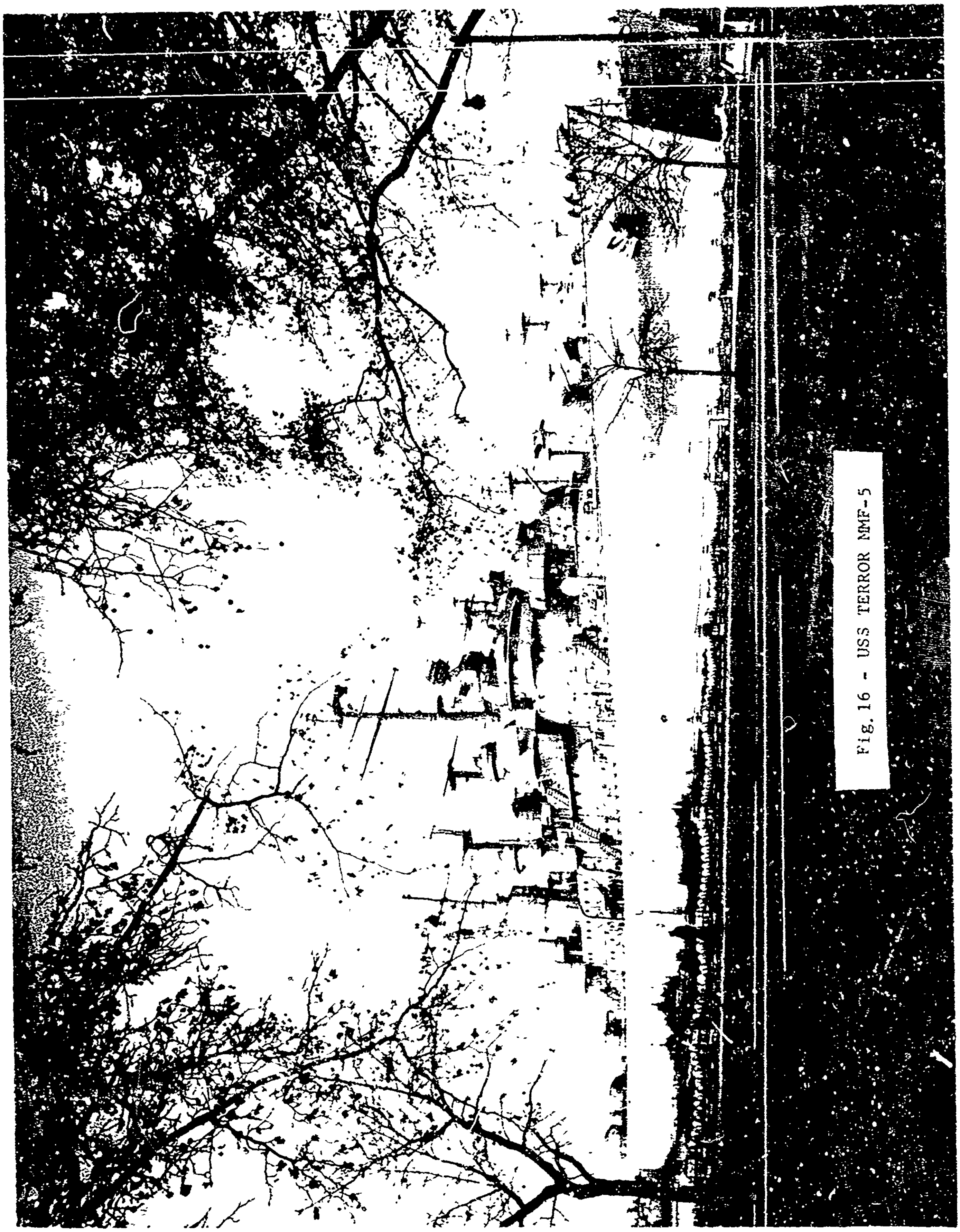


Fig. 16 - USS TERROR MMF-5

equipment. These two galleries were each over 300 ft long, 20 to 25 ft wide, and 13 ft high with unencumbered head room of 10 ft. The galleries were devoid of bulkheads and built-in equipment. This lent itself to ease of conversion and laboratory loading. Portable bulkheads could have been economically installed to satisfy air conditioning and ventilation requirements. The size of the galleries allowed for great flexibility of layout and provided sufficient space for the installation of major winches. The mine stowage areas below the galleries were available for cable stowage, magazines, and stowage of general laboratory equipment. An attempt was made to design spaces and equipment around existing facilities and structures to reduce removal and alteration costs.

The freeboard at the main deck was excessive for our purposes. We proposed cutting the stern and making the second deck the weather deck aft, to be serviced by a traveling crane. This crane could be utilized for handling a deep submersible vehicle. We proposed the installation of side doors to service second deck winches amidships. With this configuration, the laboratory spaces could be loaded from the stern utilizing monorails in the gallery overheads. We recommended that existing wildcats, hoists, cranes, and monorails be retained. We planned on investigating the possibility of utilizing a few 5-in. gun mounts as winch foundations.

Calculations were made relative to deep anchoring the ship. Using the USNS GIBBS as a basis of comparison, it appeared that the USS TERROR could be anchored on 5/8-in. diameter, 3 x 19, elevated yield strength wire rope; 42,000 ft of stowage was required. It was decided to increase the handling capability, however, and traction winches capable of pulling 45,000 to 50,000 lb which could accommodate 38,000 ft of 3/4-in. diameter wire rope were specified. The stern

winch was positioned to handle cable from a proposed cable well so that the ship could be used as a cable layer for deployment of bottom arrays of great length.

The electric power available was more than adequate. Four 500-kw turbine driven generators plus a 250-kw emergency diesel generator existed.

A profile sketch of the proposed conversion is shown in Fig. 17 and an inboard profile is shown in Fig. 18. All of the proposed conversion plans for the ship included in this report show proposed changes to meet the scientific and engineering needs of Hudson Laboratories and do not reflect reassignment of compartments connected with operations and hotel facilities.

A number of plans were discussed relating to the moving crane shown at the stern. A major problem was providing for safe handling of a deep submersible research vessel from the stern, and definitive plans were never finalized. Winch and stowage drum locations are shown. The forward traction winch was to be serviced by the bow "U" frame with a monorail provided for handling ground tackle used for deep anchoring. Vertical stowage of equipment was to be expedited by use of existing mine elevators.

Figure 19 is a plan view of the main deck conversion showing scientific berthing areas. Heads are provided contiguous with each stateroom. Accommodations were planned for a scientific party of 32 plus 12 temporary berths. Actually, many more could have been accommodated, but we were attempting to keep crew size to a minimum. A very large forward scientific boatswain's locker is provided adjacent to the forward traction winch. A library, scientific radio room, scientific navigation laboratory, and provision for ammunition handling and stowage comprise the balance of the scientific space on this deck.

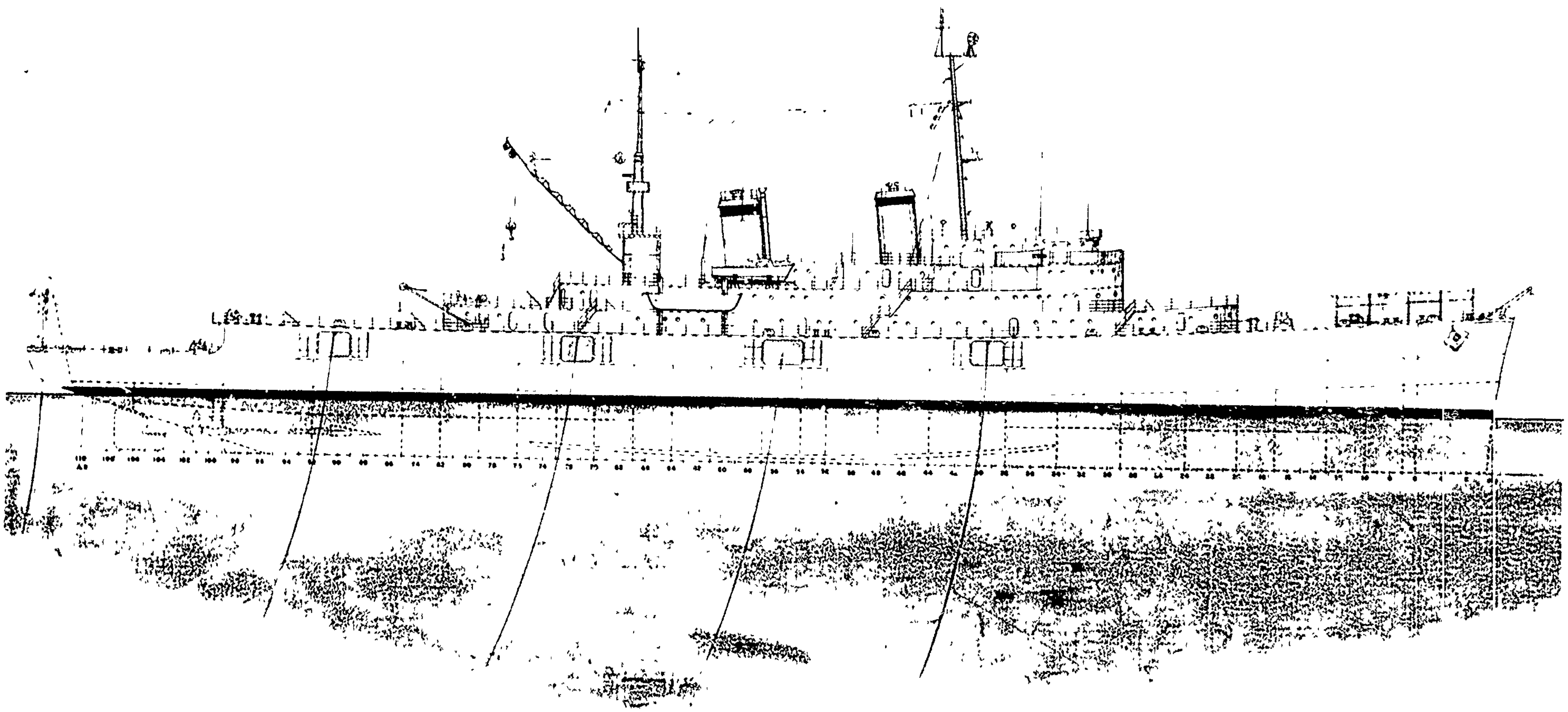
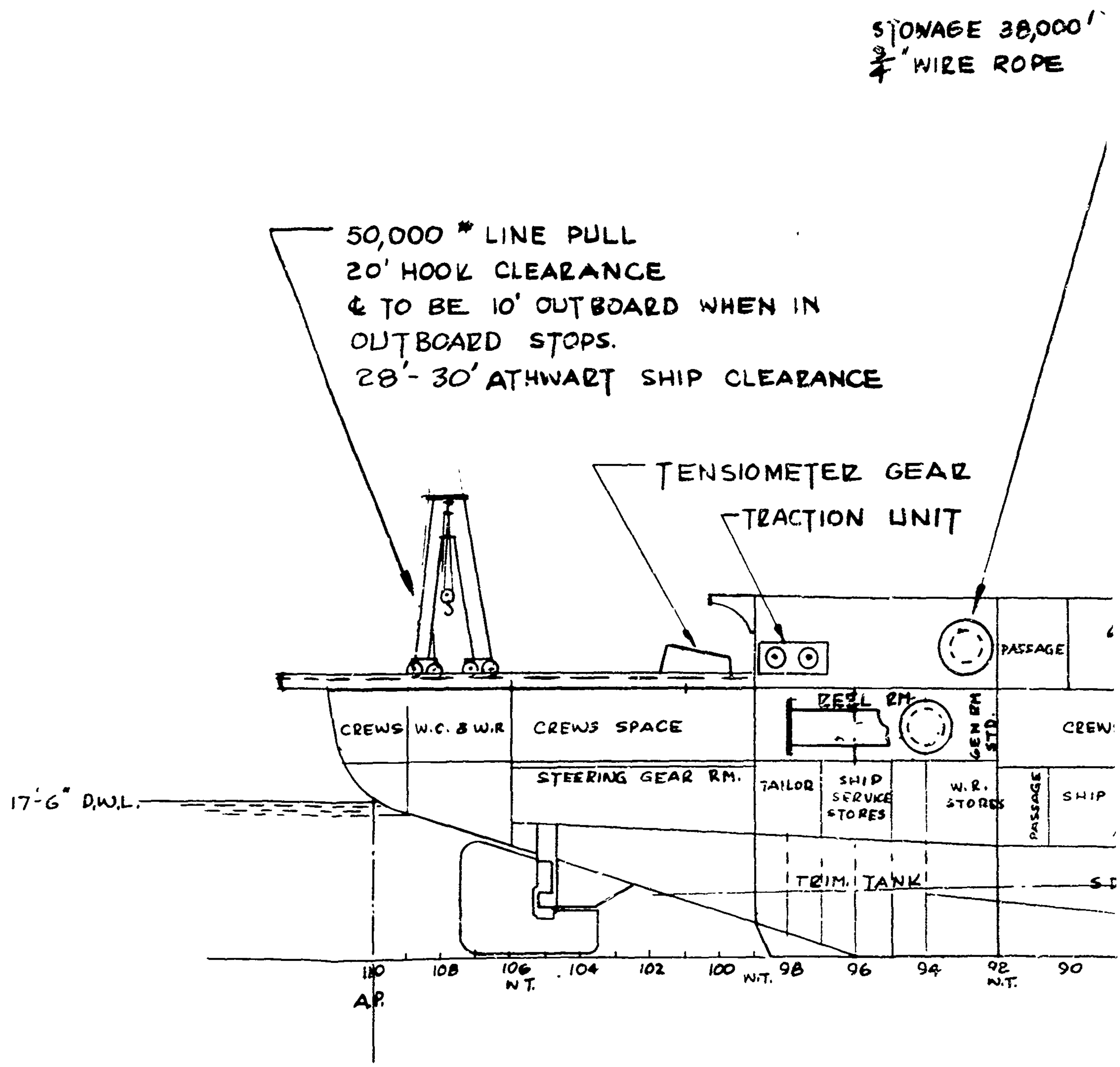
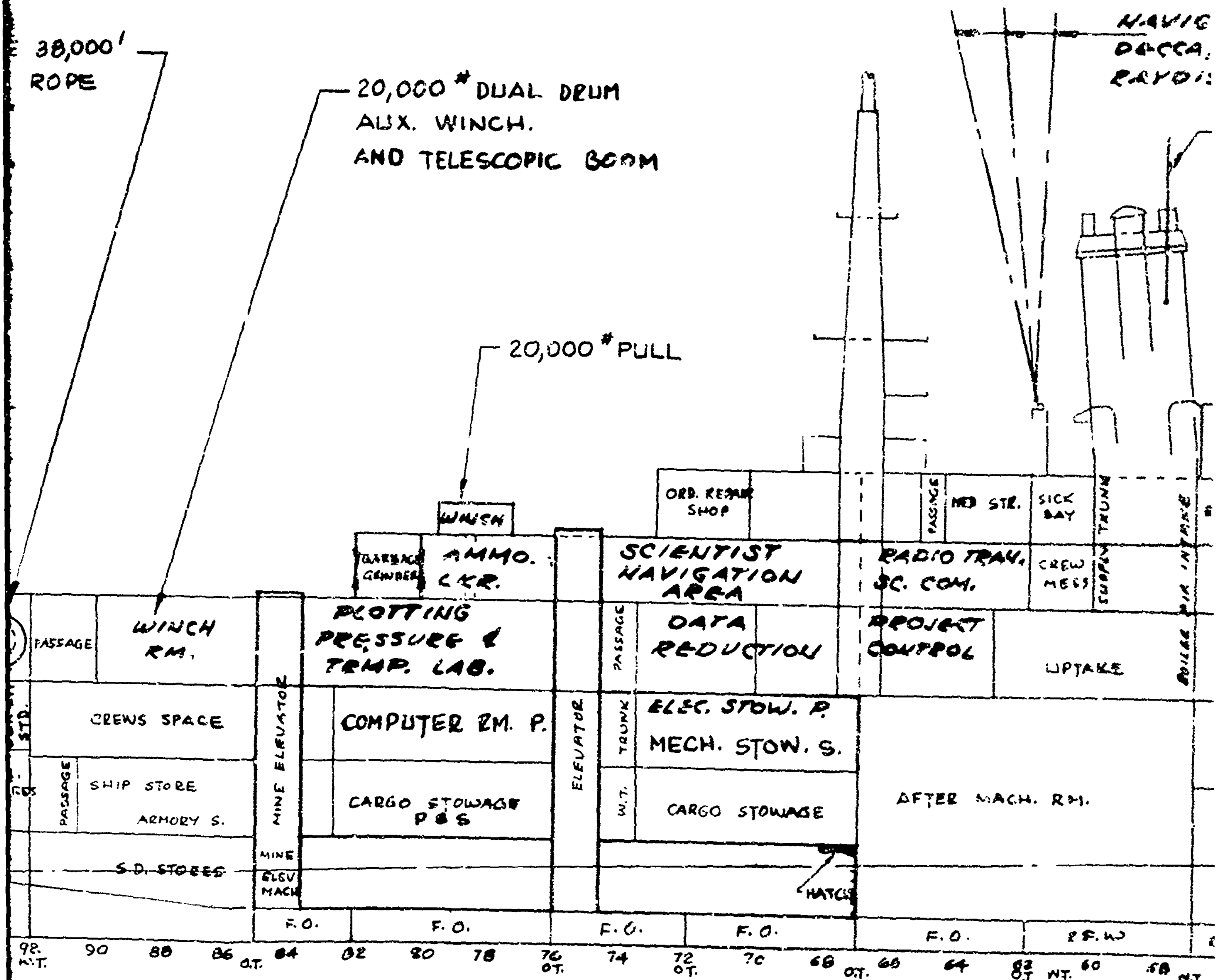
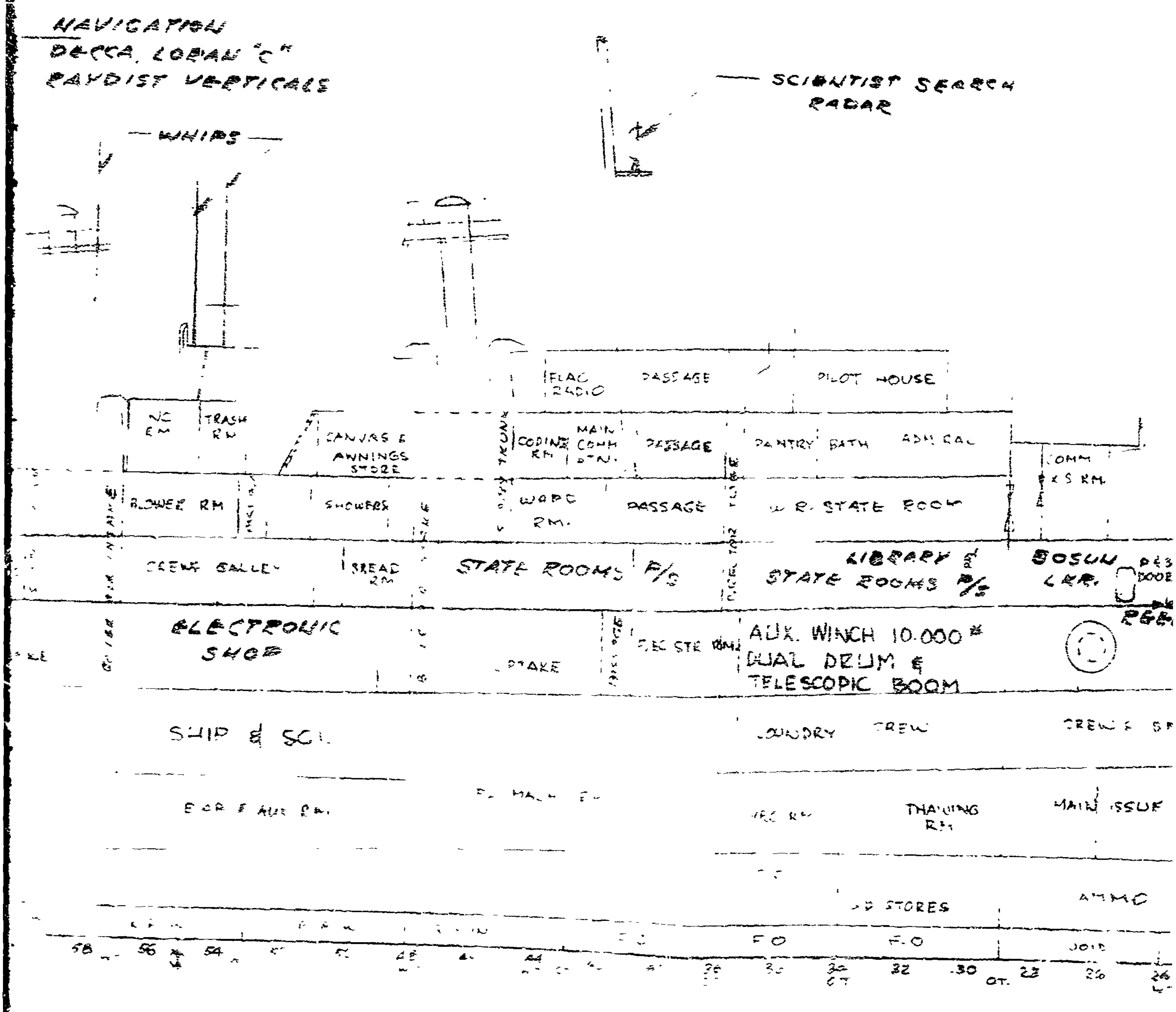


Fig. 17 - Artist's sketch of proposed Conversion of USS TERROR MMF-5 to a Research Vessel


STOWAGE 38,000'
$\frac{3}{4}$" WIRE ROPE
50,000 # LINE PULL
20' HOOK CLEARANCE
℄ TO BE 10' OUTBOARD WHEN IN
OUTBOARD STOPS.
28'-30' ATHWART SHIP CLEARANCE
TENSIOMETER GEAR
TRACTION UNIT
PASSAGE
REEL RM.
GEN RM STD.
CREWS
W.C. & W.R.
CREWS SPACE
STEERING GEAR RM.
TAILOR
SHIP SERVICE STORES
W.R. STORES
PASSAGE
SHIP
17'-6" D.W.L.
TRIM. TANK
110
108
106 N.T.
104
102
100
W.T.
98
96
94
92 W.T.
90
A.P.



38,000' ROPE
20,000 # DUAL DRUM AUX. WINCH. AND TELESCOPIC BOOM
20,000 # PULL
WINCH
GARBAGE GRINDER
AMMO. LKR.
ORD. REPAIR SHOP
SCIENTIST NAVIGATION AREA
PASSAGE
MED STR.
SICK BAY
RADIO TRAN. SC. COM.
CREW MESS
PASSAGE
WINCH RM.
PLOTTING PRESSURE & TEMP. LAB.
DATA REDUCTION
PROJECT CONTROL
UPTAKE
CREWS SPACE
MINE ELEVATOR
COMPUTER RM. P.
ELEVATOR
TRUNK
ELEC. STOW. P.
MECH. STOW. S.
SHIP STORE
ARMORY S.
CARGO STOWAGE P & S
W.T.
CARGO STOWAGE
AFTER MACH. RM.
S.D. STORES
MINE ELEV MACH
HATCH
F.O.
F.O.
F.O.
F.O.
F.O.
R.F.W.
98 W.T.
90
88
86 O.T.
84
82
80
78
76 O.T.
74
72 O.T.
70
68 O.T.
66
64
62 O.T.
W.T.
60
58 W.T.


NAVIGATION
DECCA, LORAN "C"
RAYDIST VERTICALS
WHIPS
SCIENTIST SEARCH RADAR
FLAG RADIO
PASSAGE
PILOT HOUSE
TRASH RM
CANVAS & AWNINGS STORE
CODING RM
MAIN COMM STN.
PASSAGE
PANTRY
BATH
ADMIRAL
COMM
BLOWER RM
SHOWERS
WARD RM.
PASSAGE
STATE ROOM
CREWS GALLEY
BREAD RM
STATE ROOMS P/S
LIBRARY &
STATE ROOMS P/S
BOSUN LKR.
ELECTRONIC SHOP
AUX. WINCH 10.000 #
DUAL DRUM &
TELESCOPIC BOOM
SHIP & SCI.
LAUNDRY
CREW
THAWING RM
MAIN ISSUE
STORES
AMMO
F.O
F.O
VOID
58
56
54
44
36
32
30
26

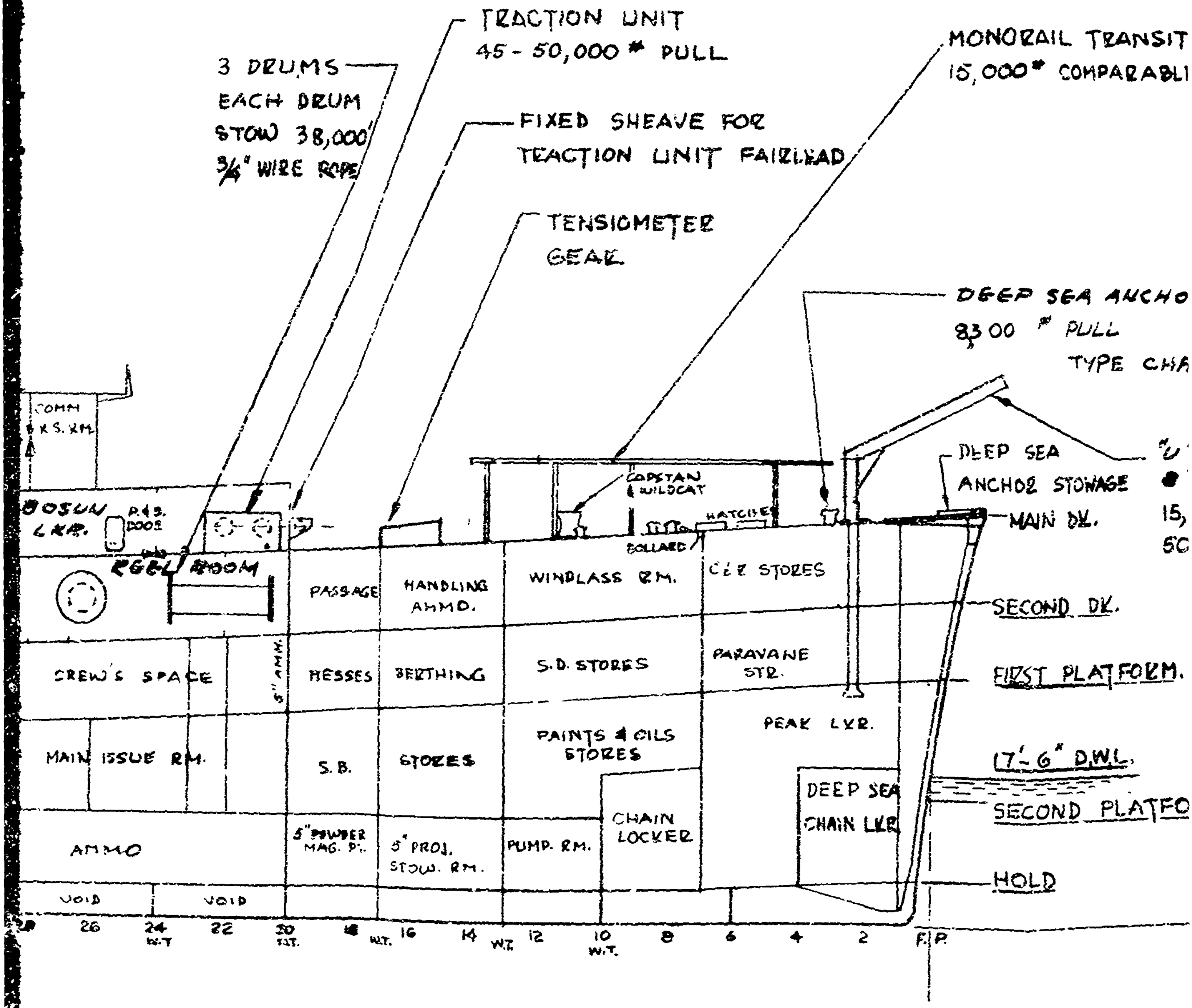


Fig. 18 - USS TERROR MMF-5

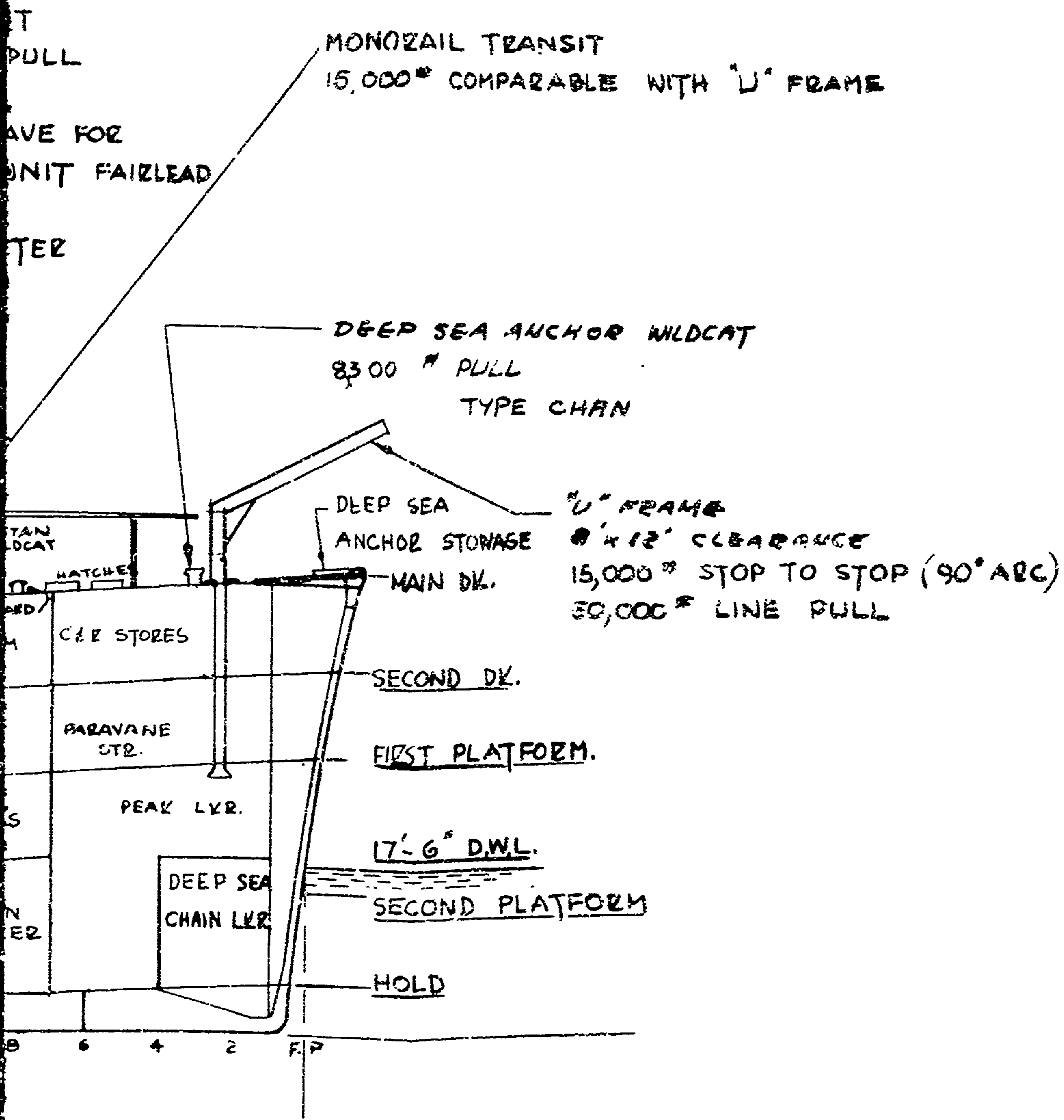


Fig.18 - USS TERROR MMF-5 - Proposed Conversion - Inboard Profile

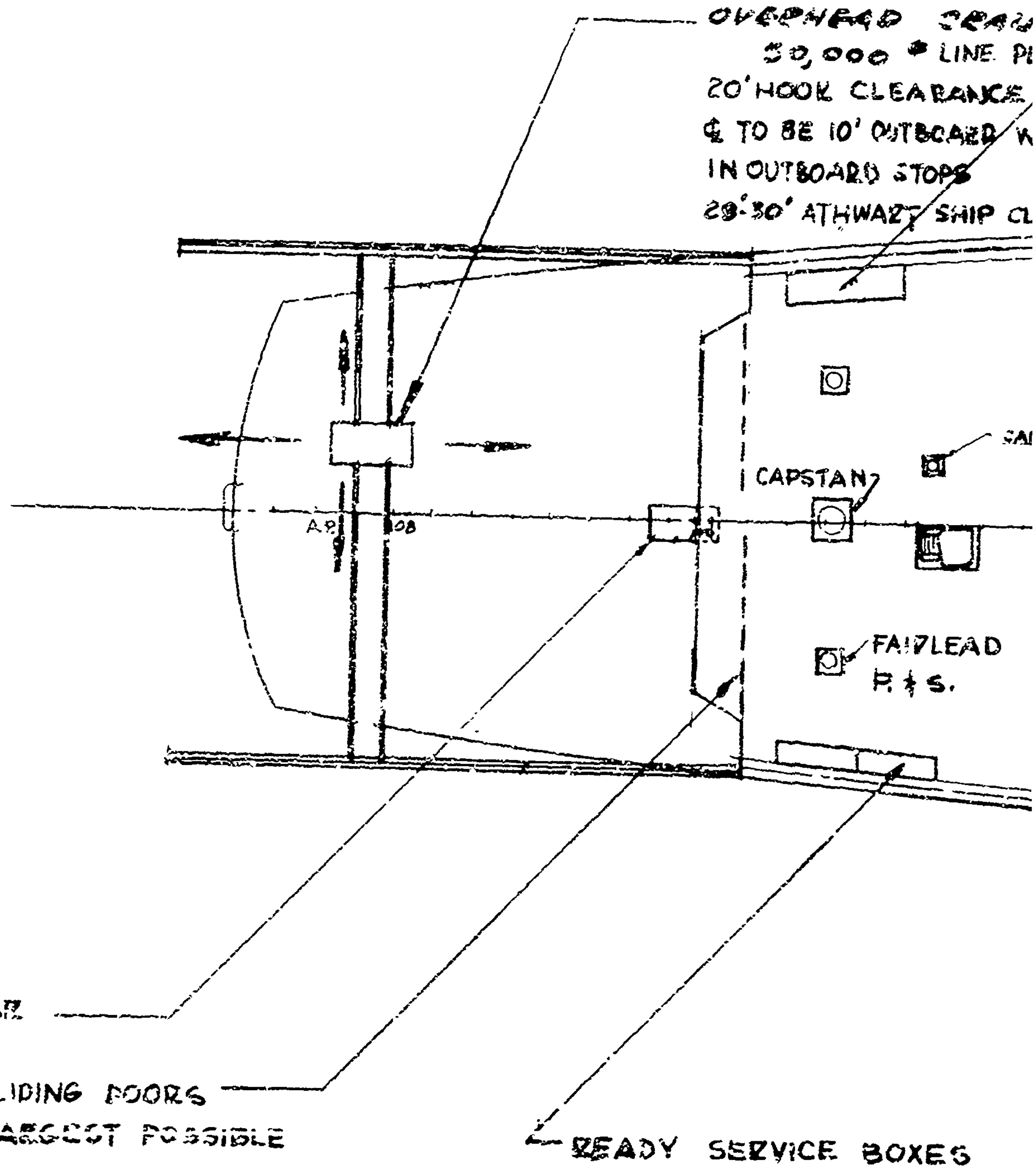
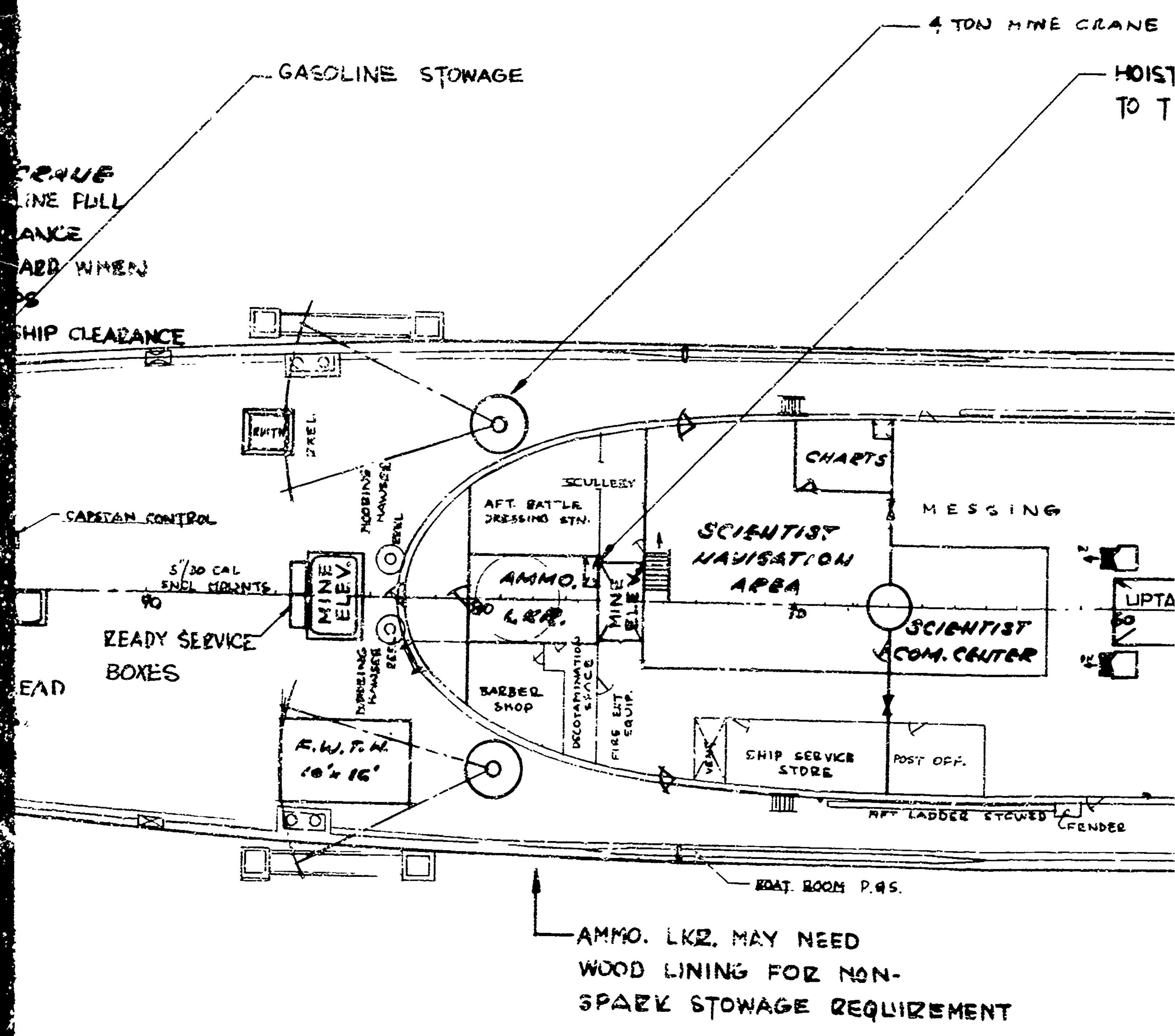


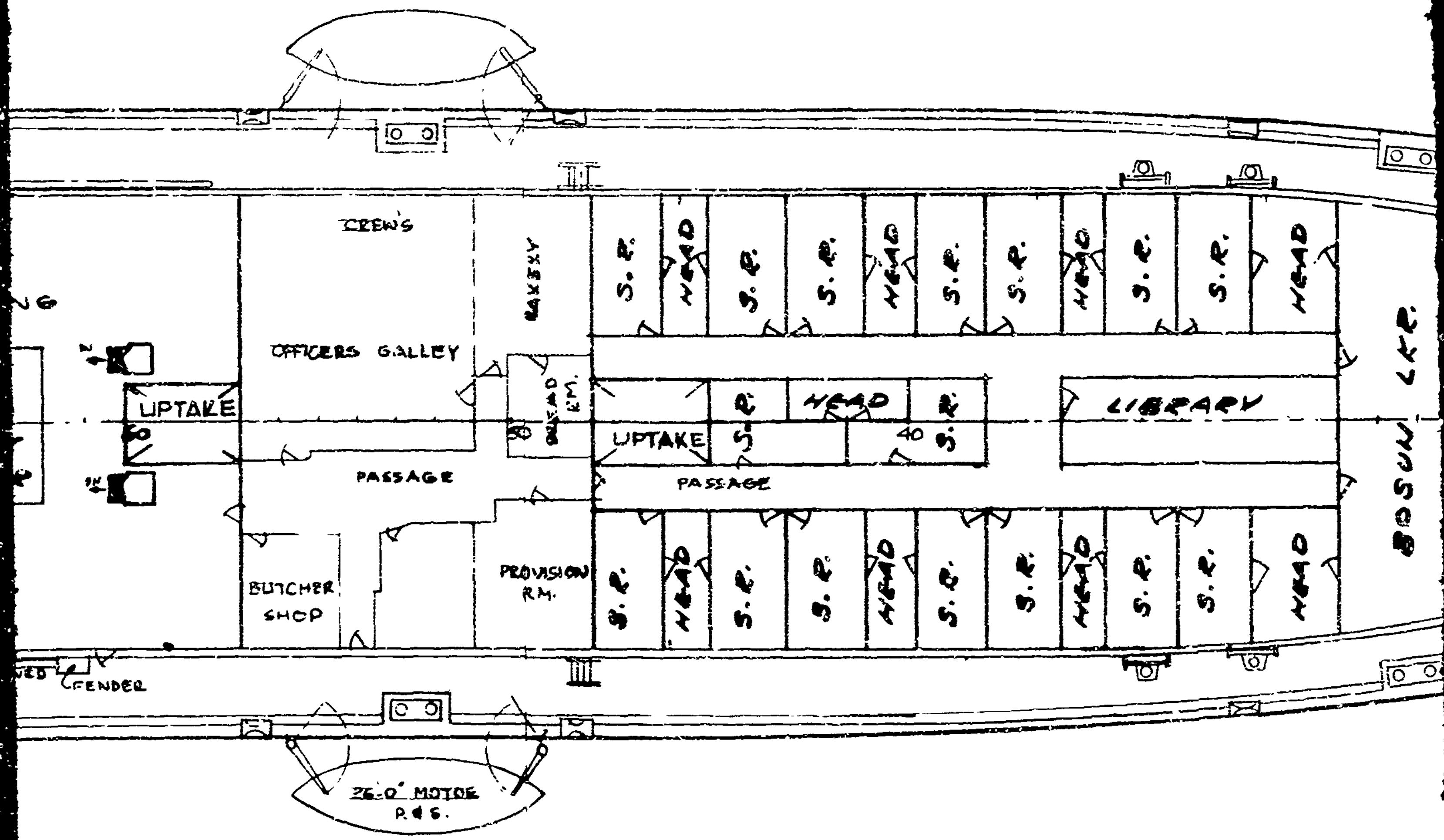
Fig. 19 - USS TERROR MMF-5 - Proposed Conversion - Main Deck

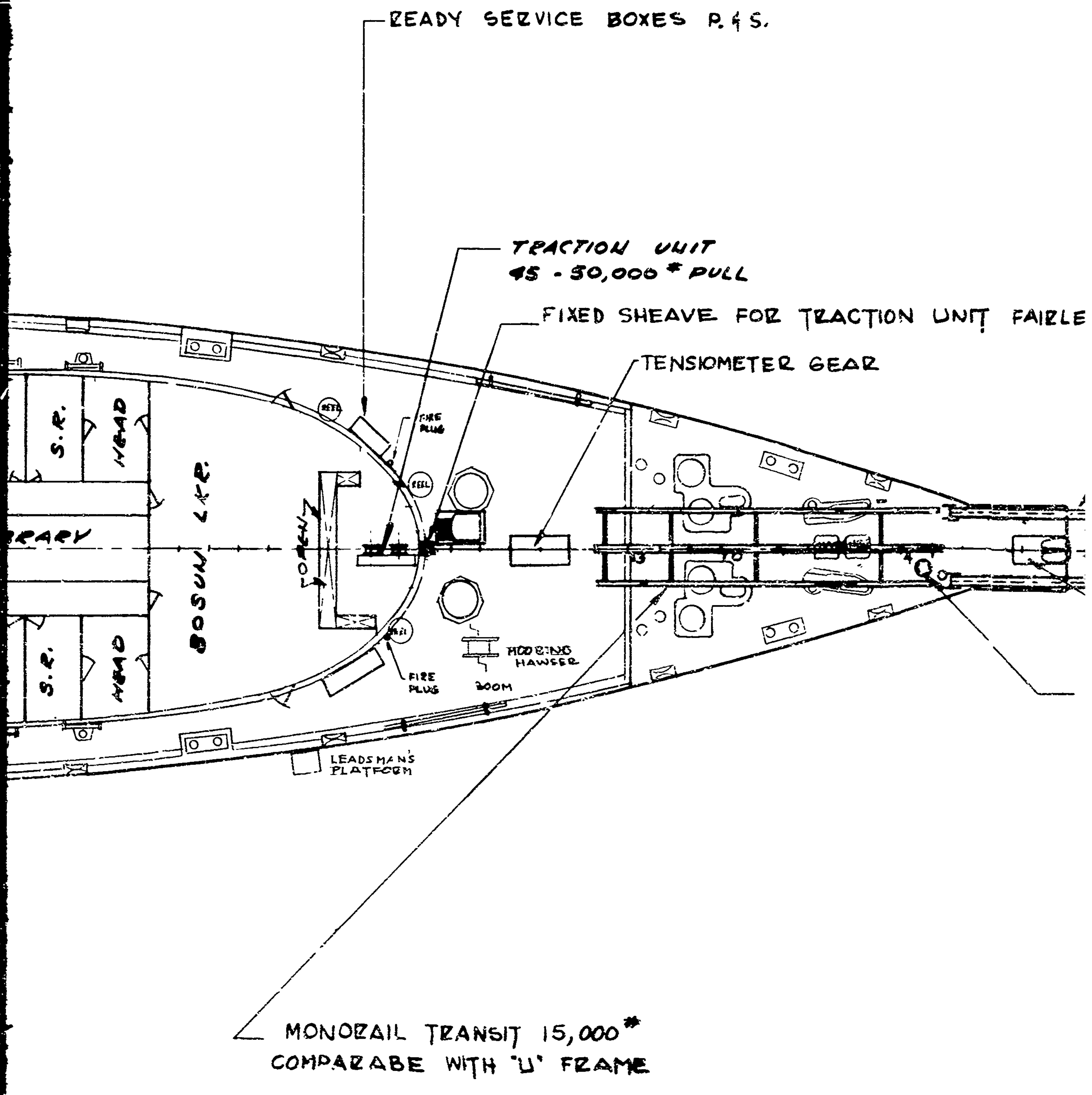

4 TON MINE CRANE
HOIST
TO T
GASOLINE STOWAGE
LINE PULL
ANCE
ARD WHEN
SHIP CLEARANCE
CAPSTAN CONTROL
5"/30 CAL
ENCL MOUNTS
MINE ELEV.
READY SERVICE
BOXES
EAD
MOORING HAWSER
SCULLERY
AFT. BATTLE
DRESSING STN.
AMMO.
LKR.
MINE ELEV.
SCIENTIST
NAVIGATION
AREA
CHARTS
MESSING
SCIENTIST
COM. CENTER
UPTA
BARBER
SHOP
DECONTAMINATION
SPACE
FIRE EXT
EQUIP.
F.W.T.H.
SHIP SERVICE
STORE
POST OFF.
LADDER STOWED
FENDER
BOAT ROOM P.&S.
AMMO. LKR. MAY NEED
WOOD LINING FOR NON-
SPARK STOWAGE REQUIREMENT

10

HE CRANE

HOIST TO BE ABLE
TO TRANSPORT A 50# BOX UP OR DOWN




READY SERVICE BOXES P.&S.
TRACTION UNIT
45-50,000# PULL
FIXED SHEAVE FOR TRACTION UNIT FAIRLE
TENSIOMETER GEAR
S.R.
HEAD
S.R.
HEAD
BOSUN LKR.
RARY
FIRE PLUG
REEL
FIRE PLUG
MOORING HAWSER
BOOM
LEADSMAN'S PLATFORM
MONORAIL TRANSIT 15,000#
COMPARABE WITH 'U' FRAME

N UNIT FAIRLEAD.

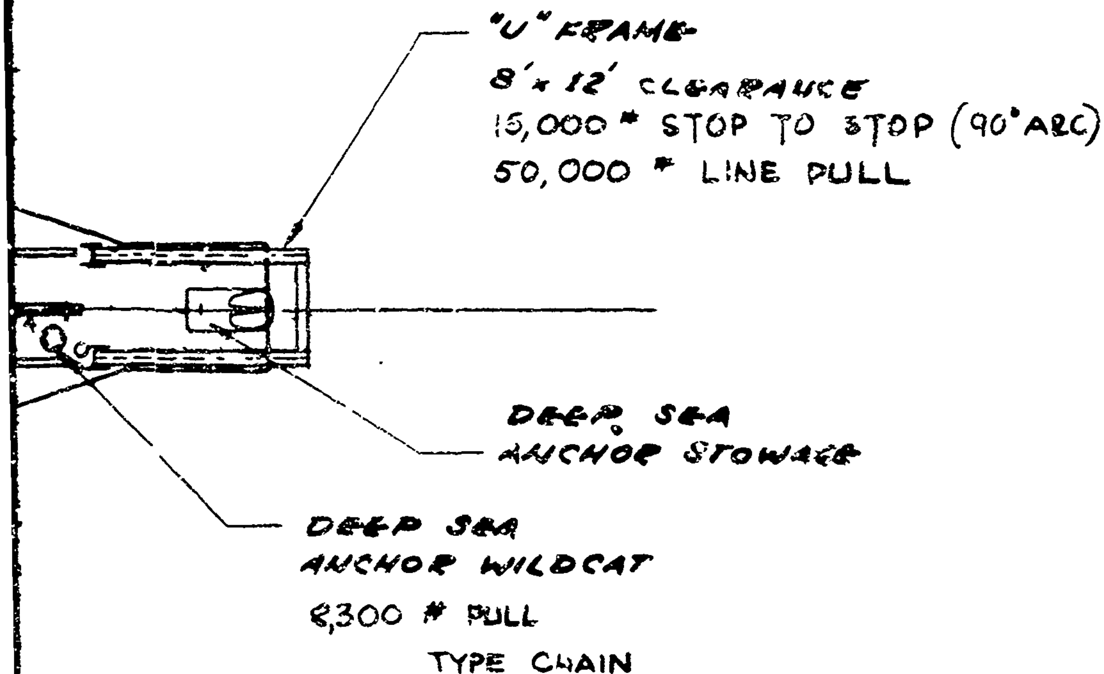


Figure 20 is a conversion plan for the second deck. This was to be the main scientific working deck with laboratories installed the entire length of the port mine-laying gallery and with winches and booms installed in the starboard gallery. The areas between winches were quite suitable for assembly work. Both galleries were to be enclosed with access doors provided adjacent to the winches. The centerline areas were to be equipped as laboratories and shops. The after traction unit and one stowage reel were to be mounted aft with stowage for rigging equipment nearby. Three stowage drums for the forward traction winch were to be placed aft of frame 20.

Figure 21 is a conversion plan for the first platform. After traction winch stowage drums, extremely commodious stowage compartments, a computer room, and a machine shop were proposed for this deck.

A preliminary equipment list was prepared in order to assist BuShips in arriving at an outfitting and installation cost. This list is included as Appendix A to this report.

MSTS estimated manning requirements as 13 officers, 7 CPOs and 44 men, or a total crew of 64. This estimate was based on provision of a centralized engineering control station with remote control and operation of auxiliary machinery and complete automation of boiler control. If these controls could not be provided, MSTS estimated that an additional 2 officers and 17 men would have to be added, bringing the total crew to 83.

BuShips' estimate for converting, refurbishing, outfitting, and automating the plant was in the order of $16 million. On the basis of this extremely high estimate, all plans for conversion of the USS TERROR were dropped in favor of new construction. BuShips estimated that our scientific area requirements could be met by construction of a 4000-ton hull similar to that shown in Fig. 8.

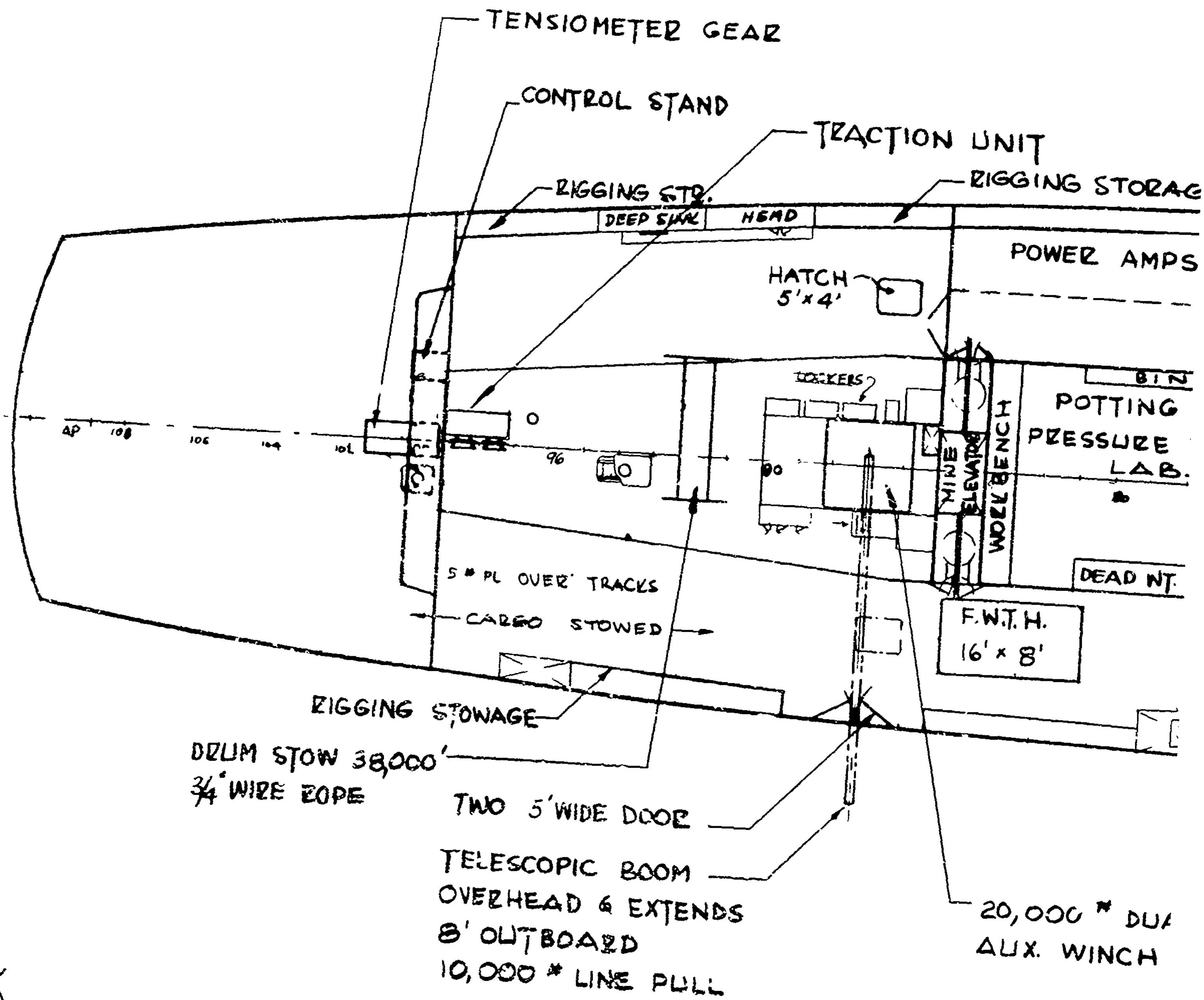
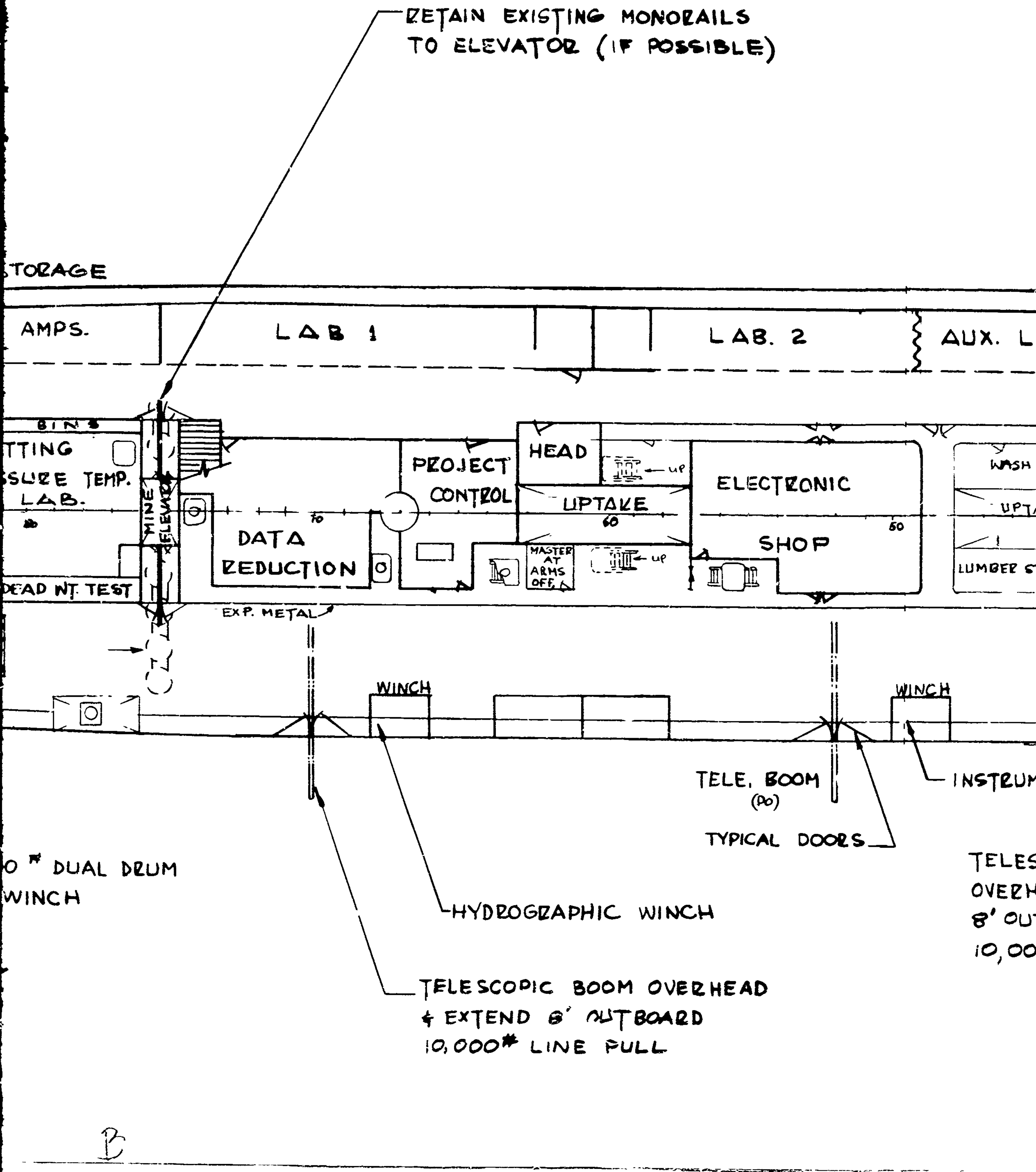
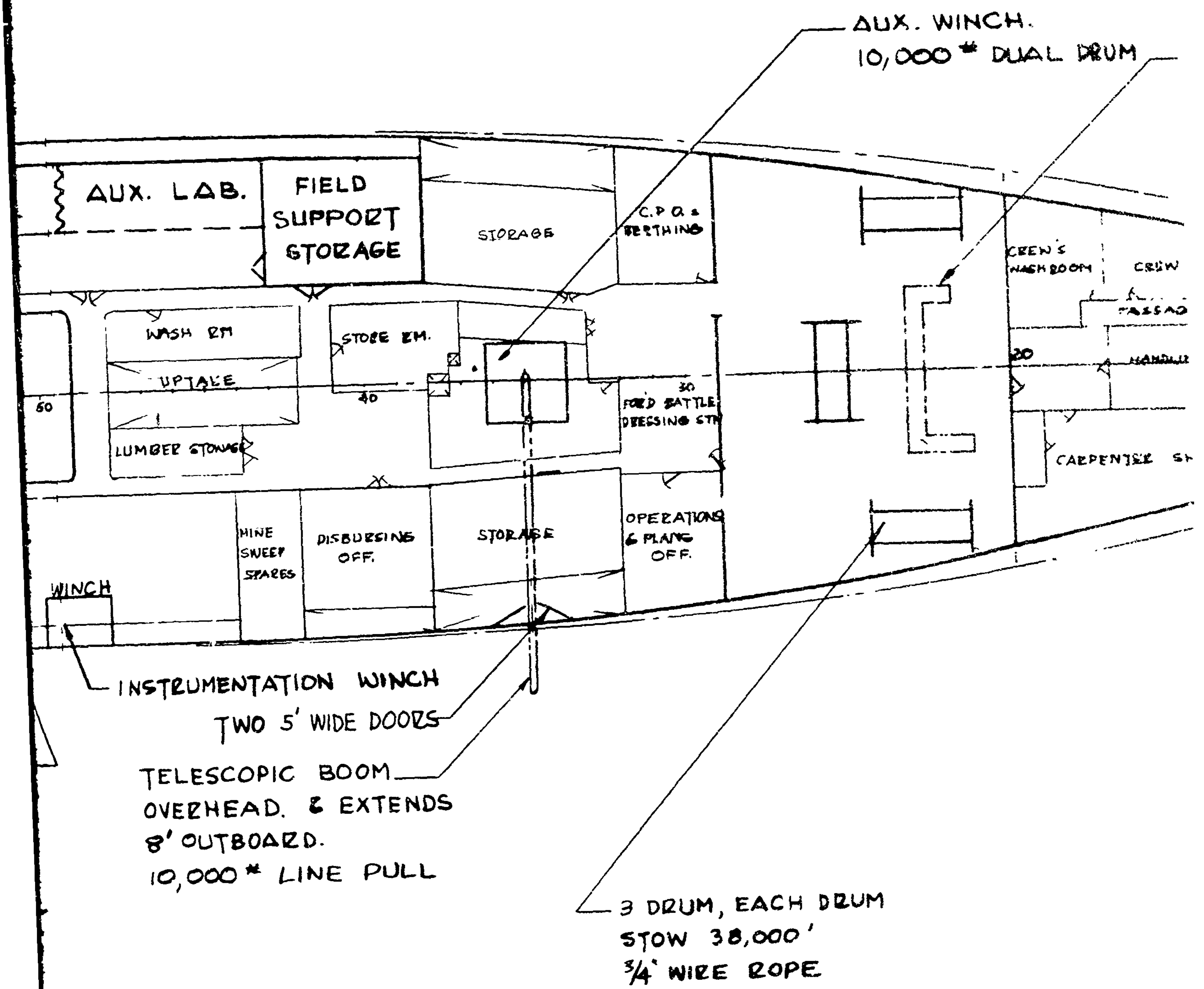
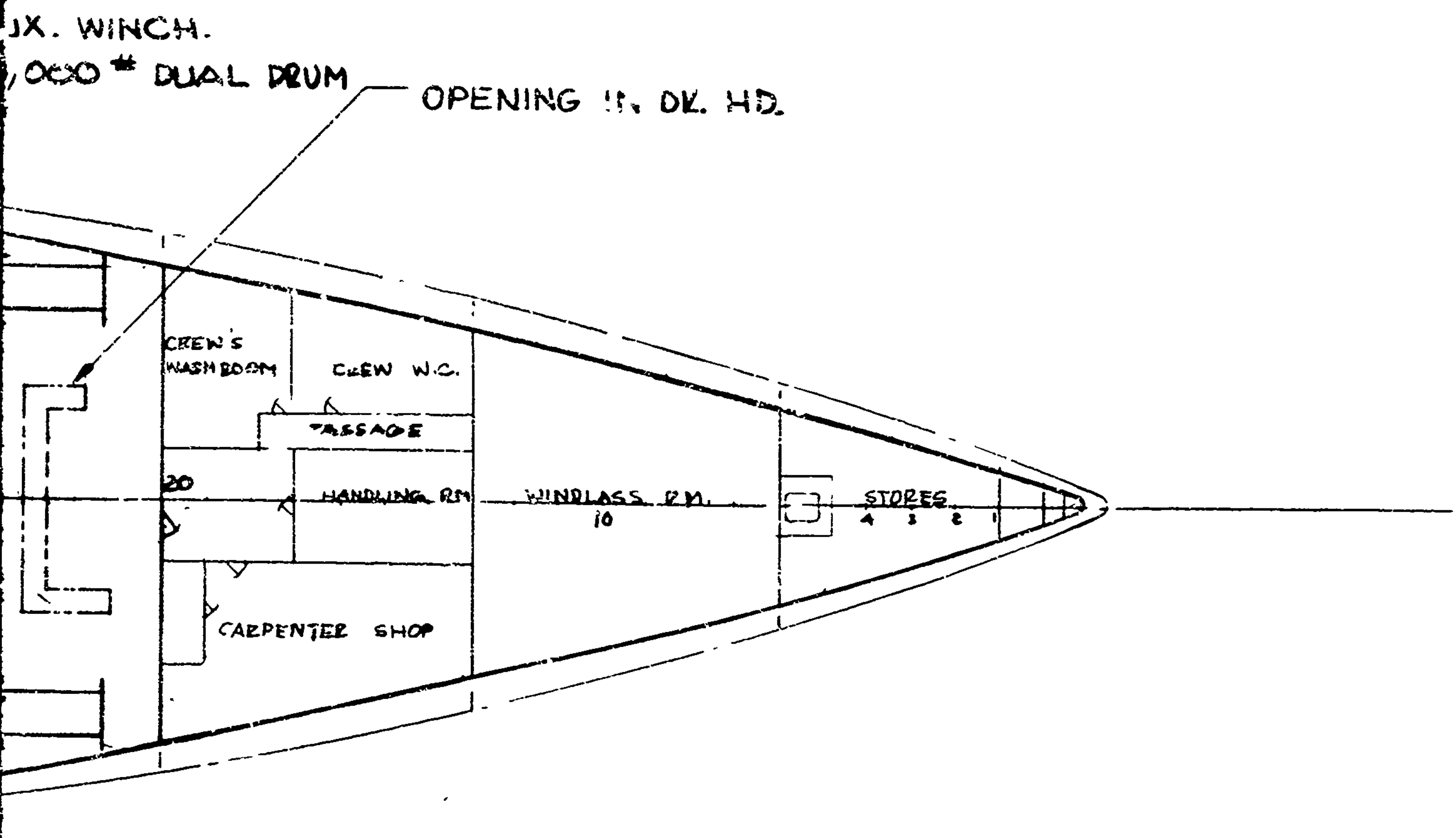


Fig. 20 - USS TERROR MMF-5 - Conversion Plans Second Deck

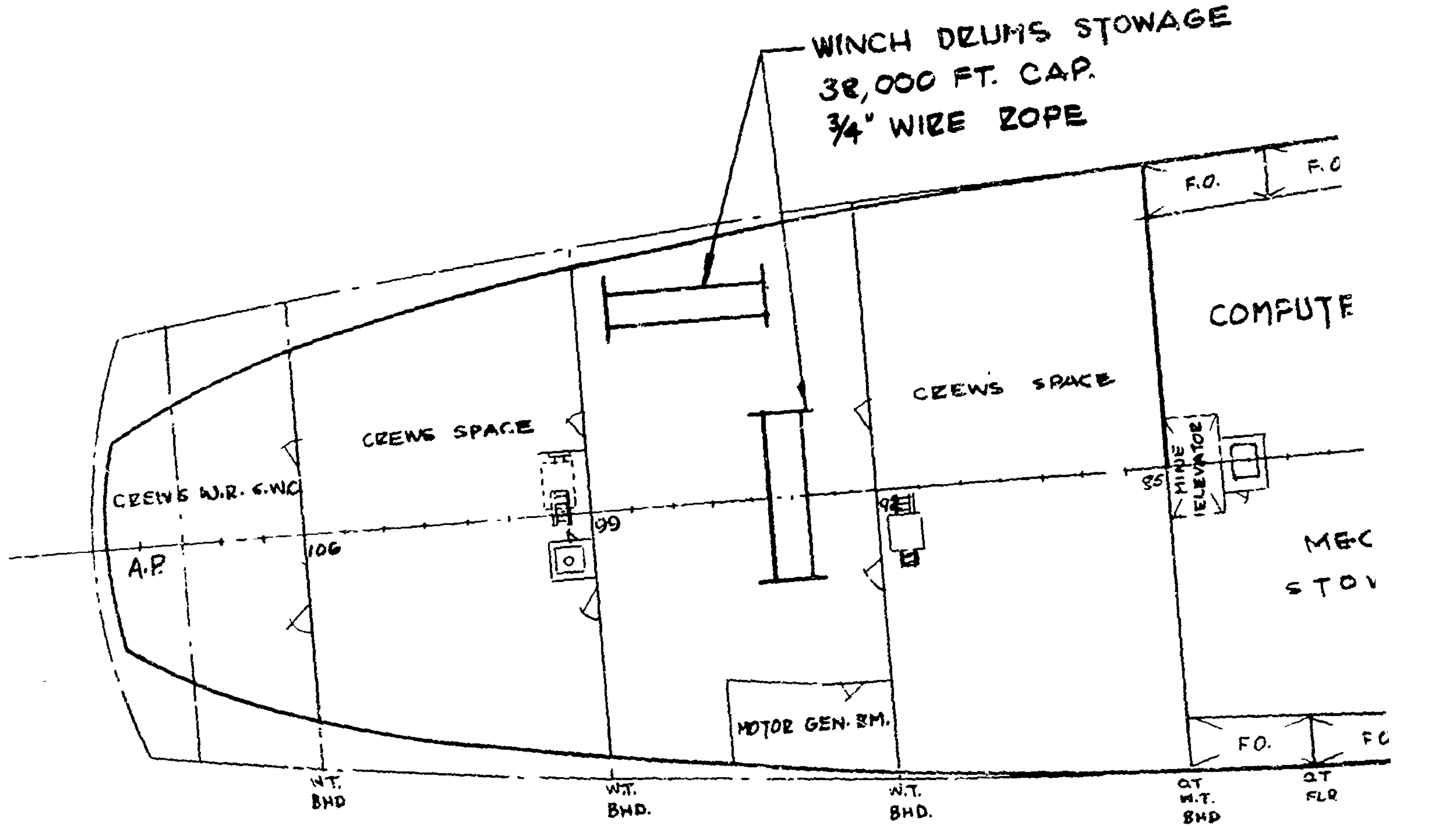

RETAIN EXISTING MONORAILS
TO ELEVATOR (IF POSSIBLE)
STORAGE
AMPS.
LAB 1
LAB. 2
AUX. L
BINS
TTING
SSURE TEMP.
LAB.
DEAD WT. TEST
MINE ELEVATOR
DATA
REDUCTION
PROJECT
CONTROL
HEAD
UPTAKE
MASTER AT ARMS OFF.
ELECTRONIC
SHOP
WASH
LUMBER S
UP
EXP. METAL
WINCH
WINCH
TELE. BOOM
(PO)
TYPICAL DOORS
INSTRUM
O # DUAL DRUM
WINCH
HYDROGRAPHIC WINCH
TELESCOPIC BOOM OVERHEAD
& EXTEND 8' OUTBOARD
10,000# LINE PULL
TELES
OVERH
8' OU
10,00
B



AUX. WINCH.
10,000 # DUAL DRUM
AUX. LAB.
FIELD SUPPORT STORAGE
STORAGE
C.P.O.s BERTHING
WASH RM
STORE RM.
UPTAKE
LUMBER STOWAGE
FWD BATTLE DRESSING STA
CREW'S WASHROOM
CREW
CARPENTER SH
MINE SWEEP SPARES
DISBURSING OFF.
STORAGE
OPERATIONS & PLANS OFF.
WINCH
INSTRUMENTATION WINCH
TWO 5' WIDE DOORS
TELESCOPIC BOOM
OVERHEAD. & EXTENDS
8' OUTBOARD.
10,000 # LINE PULL
3 DRUM, EACH DRUM
STOW 38,000'
3/4" WIRE ROPE



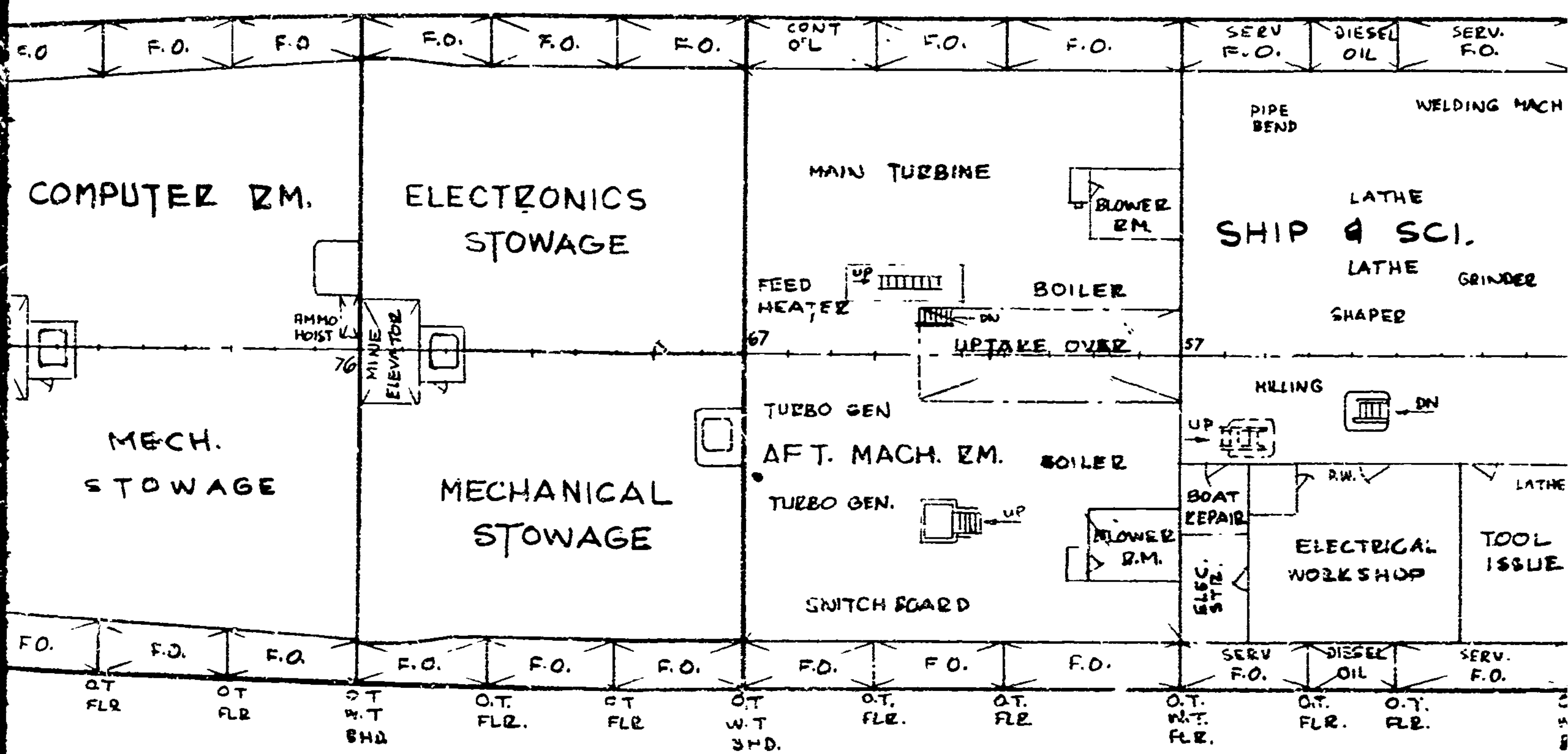
JX. WINCH.
,000 # DUAL DRUM
OPENING IN DK. HD.
CREW'S WASHROOM
CREW W.C.
PASSAGE
20
HANDLING RM
WINDLASS RM.
10
STORES
4 3 2 1
CARPENTER SHOP



WINCH DRUMS STOWAGE
38,000 FT. CAP.
3/4" WIRE ROPE
F.O.
F.O
COMPUTE
CREWS SPACE
CREWS SPACE
CREWS W.R. & W.C.
A.P.
106
99
92
85
MINE ELEVATOR
MEC
STOV
MOTOR GEN. RM.
F.O.
F.O
W.T. BHD
W.T. BHD.
W.T. BHD.
O.T. W.T. BHD
O.T. FLR

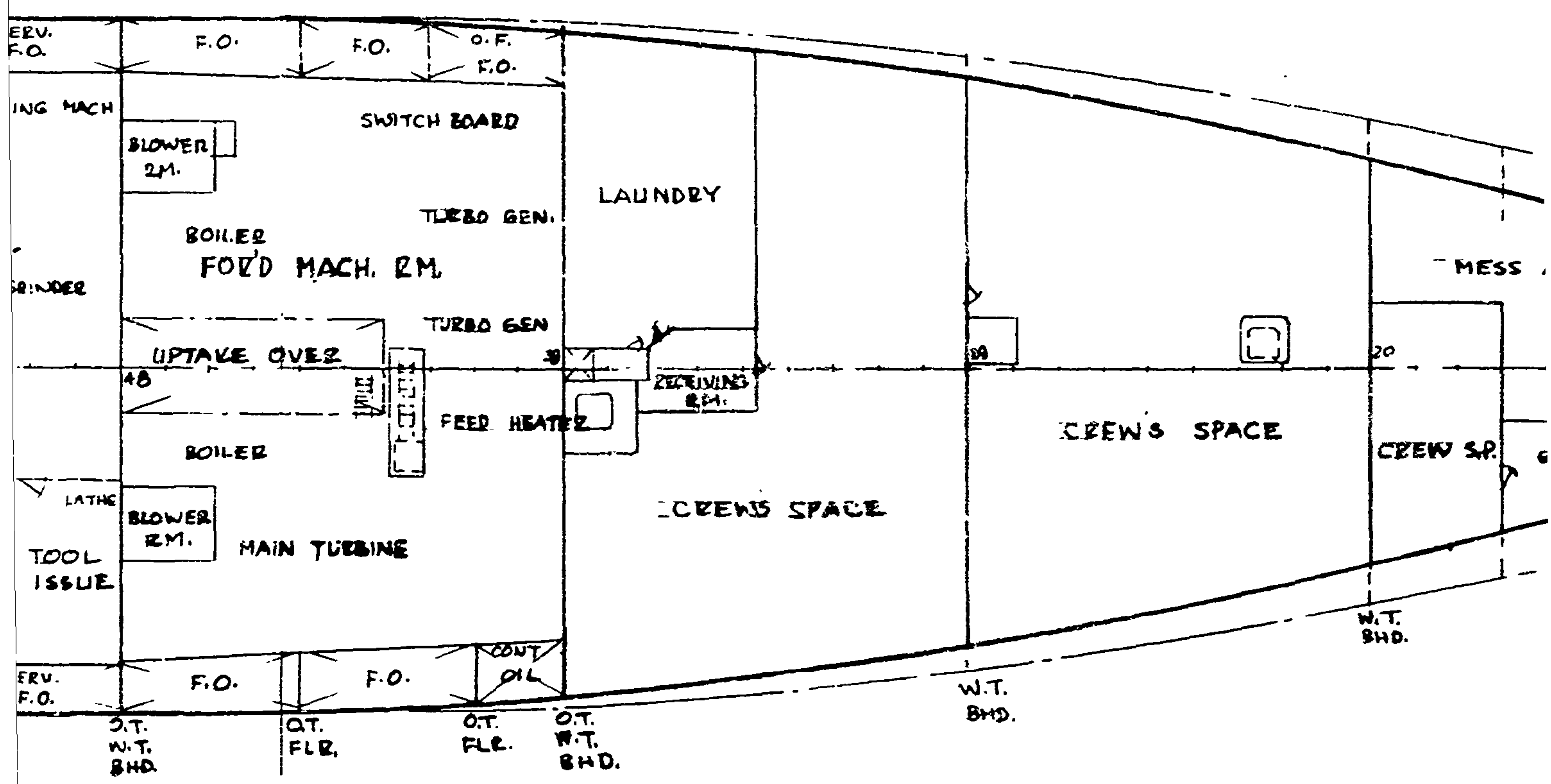
A

AGE



F.O.
CONT O'L
SERV F.O.
DIESEL OIL
COMPUTER RM.
ELECTRONICS STOWAGE
MAIN TURBINE
BLOWER RM.
PIPE BEND
WELDING MACH
LATHE
SHIP & SCI.
GRINDER
SHAPER
FEED HEATER
BOILER
UPTAKE OVER
AMMO HOIST
MINIE ELEVATOR
76
67
57
MILLING
UP
DN
MECH. STOWAGE
MECHANICAL STOWAGE
TURBO GEN
AFT. MACH. RM.
TURBO GEN.
SWITCH BOARD
BOAT REPAIR
ELEC. STR.
R.W.
ELECTRICAL WORKSHOP
TOOL ISSUE
O.T. FLR.
O.T. W.T. BHD.

3



ERV. F.O.
F.O.
F.O.
O.F. F.O.
ING MACH
SWITCH BOARD
BLOWER RM.
LAUNDRY
TURBO GEN.
BOILER
FOR'D MACH. RM.
RINDER
TURBO GEN
MESS
UPTAKE OVER
48
RECEIVING RM.
20
FEED HEATER
CREW'S SPACE
BOILER
CREW SP.
LATHE
CREWS SPACE
BLOWER RM.
TOOL ISSUE
MAIN TURBINE
W.T. BHD.
CONT OIL
ERV. F.O.
F.O.
F.O.
W.T. BHD.
O.T. W.T. BHD.
O.T. FLR.
O.T. FLR.
O.T. W.T. BHD.

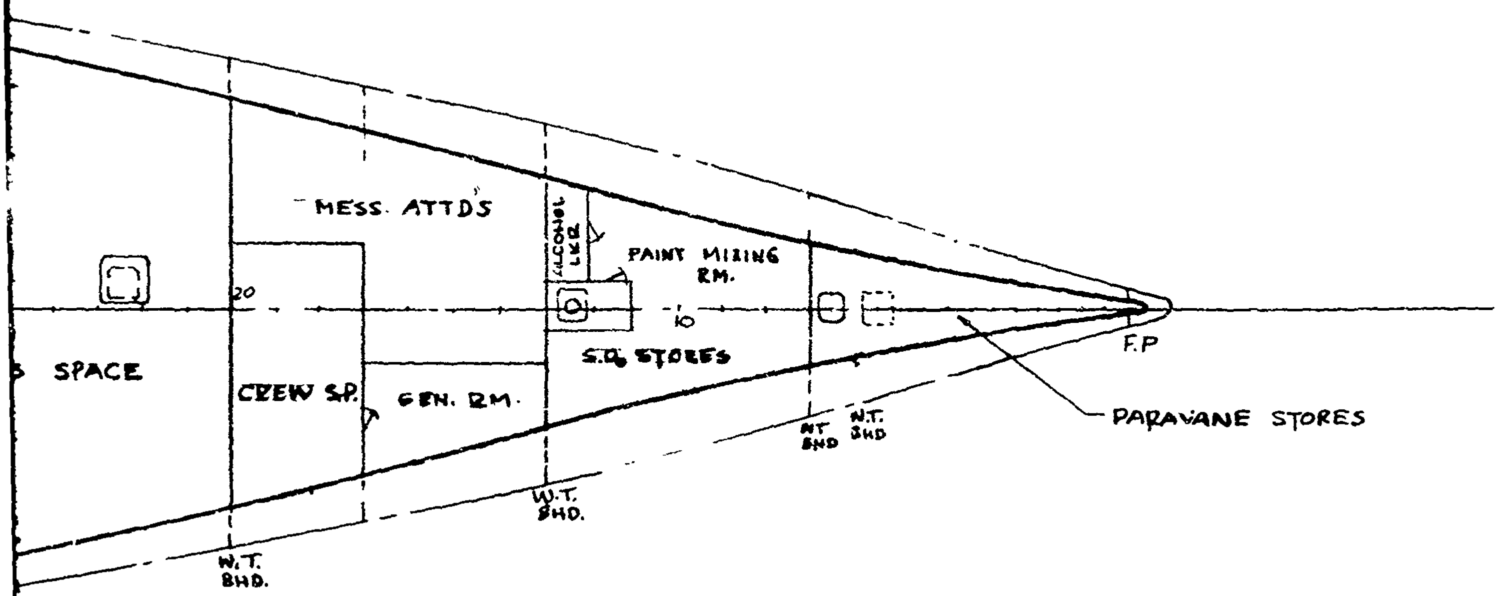


Fig. 21 - USS TERROR MMF-5 - Conversion Plans First Platform

IV CONVENTIONAL HULL PROPOSAL BY SHIPS CHARACTERISTICS BOARD

On March 14, 1966, the Ships Characteristics Board promulgated characteristics for an oceanographic research vessel. The first vessel of this class was scheduled for use by Hudson Laboratories. The characteristics called for a conventional hull with an overall length of 306 ft. 49-ft beam and a draft of 16 ft, with a full load displacement of 3200 tons. Sustained speed was specified at 16 knots with a range of 12,000 miles at that speed. The power plant was to be single screw diesel-electric with bridge control. In addition, a rotatable bow propulsion unit and an active rudder were to be provided for quiet, low speed propulsion, heading control when dead in the water, and for maneuverability.

Scientific berthing was to be provided for 30, and the crew was to be composed of 12 officers, 4 CPOs and 29 men, or a total of 45. Adequate open deck areas were to be provided forward and aft. Space and weight reservation was to be made for a 10 x 10 ft well through the ship near the center of least motion. A passive anti-roll system was to be provided and the trailing edge of the rudder was to be located 10 ft forward of the stern. A large bulbous bow was to be provided for observations and housing of acoustic equipment. A 50-ton future growth margin at the main deck was specified and acoustic silencing techniques were to be employed to reduce machinery radiated noise when operating at low speed.

Scientific chill and freeze compartments and provision for storing 50 tons of explosives were specified. A separate power and distribution system for scientific use was to be provided. All living, messing, laboratory and office spaces were to be air conditioned. Provision was to be made for deeo anchoring by the bow.

No comprehensive list of handling gear was included. The characteristics called for "winches, articulated cranes, davits and U-frames". A detailed list of radio, radar, sonar, navigation and other equipment was included in an appendix to the characteristics.

In reviewing these specifications, it became apparent that the 306-ft hull would not provide the area requested in our preliminary specifications of 1963. In regard to the 50-ton future growth margin, we questioned if this were to be the growth allowed after the ship was fully loaded and equipped, including the full electronic suite, handling gear, cable, etc. We commented in some detail on data distribution and on line data processing.

We recommended that the scientific office and library be combined and that two day rooms be provided. A mechanical engineering laboratory for test and assembly of equipment readily accessible to the open deck, an electronic workshop and a power amplifier room were requested. We requested that the scientific chill and freeze rooms and the explosives stowage be reduced in volume. We stated our need for large hatches for vertical loading of the scientific areas plus monorails for horizontal movement of equipment.

Hudson Laboratories did not require the proposed bulbous bow, and we were concerned that it might be damaged by ground tackle or cable during deep anchoring evolutions. We insisted on provision for a scientific radio facility separate and distinct from the ship's communications equipment. We requested more detailed information on the auxiliary propulsion equipment since problems had occurred with the bow propulsion units on other research and survey vessels. We stipulated that we did not consider a waste heat distilling plant satisfactory since we frequently anchored on station for long periods during which the main propulsion diesles would not be operated.

We specifically requested that the crew include an electrician, boatswain, machinist-plumber and a deck machinery maintenance man. The USNS GIBBS had included all of the above except the maintenance man. Because of the lack of the deck machinery maintenance man, a good deal of the day-to-day preventative and corrective maintenance work was postponed to the annual shipyard period which was an unsatisfactory and expensive alternative.

We requested scientific berthing to be provided in the form of rooms for two with contiguous heads and showers. In lieu of laundry service, we requested that a washing machine and dryer be available for use by individuals.

We specified the machine tools and welding equipment for the machine shop and stated that we wished to share the facilities with the ship's force. In addition to instrumented vans, we stated that we frequently installed portable winches which required deck stiffening and power outlets. We were concerned that the midship well called for was too small for most uses and yet removed a great deal of laboratory space since it pierced many decks and would require considerable stiffening. In lieu of the well, we requested a cable well on one deck in order that the ship could function as a rudimentary cable layer.

We recommended many other features including low-pressure and high-pressure (5000 psi) air service, a built-in hydraulic oil service tank, gas bottle stowage, good open deck and overboard lighting, scientific boatswain's lockers, etc.

Our recommendations for handling gear, communications, electronic and navigation gear and power requirements are included in Appendix B.

V PRELIMINARY CATAMARAN STUDIES

Just a few weeks after reviewing the above information, we received preliminary data covering a catamaran hull being designed for use as a submarine rescue vessel (ASR). BuShips had proposed use of a similar hull for a research vessel in place of the conventional hull discussed above. Some of the ASR's characteristics were as follows:

Length overall - 234 ft 6 in.

Length between perpendiculars - 210 ft

Maximum beam - 86 ft

Beam - each hull 26 ft

Freeboard - main deck - 16 ft

Draft - 19 ft

Displacement full load - 3200 tons

Sustained speed - 16 knots

Endurance at 13 knots - 10,000 miles

Shaft hp - 6,000

Geared diesel drive

It appeared that a catamaran would provide a number of major advantages over a new design for a conventional hull. For example, laboratory space available is much greater on a catamaran of the same tonnage as a conventional ship. The large metacentric height inherent in the catamaran design provides great stability during the handling of heavy equipment and provides a very large growth potential. Great flexibility of equipment arrangement is possible when a ship's stability is not critical. With the catamaran, it is possible to satisfy the needs of laboratories dedicated to stern, side and well launching

of equipment with sufficient room forward for deep sea anchoring and for simultaneous launching of equipment forward and aft (providing the separation essential to prevention of tangling of lines). However, the original ASR design did not provide sufficient work area at the stern. With twin screws widely separated, good maneuverability is possible.

Some reservation existed in our minds concerning use of a catamaran. In which direction does one steer in heavy seas? It may be that it is not best to head into them and take the waves between the hulls. Is a ship with a roll period in the order of 5 seconds uncomfortable to ride for a long period of time? Will we be able to deep anchor such a ship from one bow without resorting to the use of a huge cable and winch? What experience exists in the operation of large catamarans? Some of these questions were answered and some must be explored after the vessel is completed.

A meeting of the Ship's Characteristics Board was convened on May 6, 1966 to discuss the proposed Hudson Laboratories oceanographic vessel. BuShips recommended a catamaran on the basis of technical advantages and earlier delivery. We have already discussed the basic technical advantages above. To meet our scientific requirements, a conventional hull would have to be larger than the 306-ft ship covered in the original characteristics. The cost of the 306-ft ship was estimated to be $12.5 million for the lead vessel and $11.1 million for the follow-on vessels. The catamaran hull was estimated at $14.5 million for the lead vessel and $13.0 million for the follow-on ships. Since the conventional hull vessel was too small for our needs, this price would rise with an increase in size. The catamaran cost would be reduced since the research version really represented a follow-on to the ASR to a degree. It should be

noted that the catamaran costs included provision for the electronic and handling equipment installed on the USNS SILAS BENT plus $.5 million but less the shipboard survey system.

It was felt that the novel catamaran approach would be approved even if the cost exceeded the $13.8 million programmed. In addition, it was suggested that a multiple ship order (that is AGORs and ASRs) might be placed to reduce the cost further.

Model hull tests had already been run at David Taylor Model Basin. One interesting result of these tests was the fact that the ship could maintain its heading if only one shaft was in use utilizing a 3-degree rudder angle.

MSTS requested a design allowing for unattended engine rooms. Cost of automation and controls was a big factor in the decision to disallow this request. In addition, Coast Guard regulations do not allow this as yet. A centralized main propulsion control station and an after control station were to be provided. MSTS estimated that a crew of 16 officers, 5 CPOs and 37 men, totaling 58, would be required. With the unmanned engine rooms, their crew estimate was 49.

Upon agreement of all parties involved that the catamaran hull approach should be pursued, the preliminary characteristics for this vessel were promulgated by the SCB on May 13, 1966 (Appendix C).

VI COMMENTS AND PROBLEMS INVOLVED WITH SCB PRELIMINARY CHARACTERISTICS FOR THE CATAMARAN RESEARCH VESSEL

The catamaran ASR plans were reviewed along with the characteristics. Very little working deck space was available at the stern of the ASR. The deckhouse aft provided areas far in excess of our scientific needs and the center well area was larger than we required on an AGOR, even considering handling of a deep submersible vehicle from this location. The Bureau of Ships structural people required three athwartship strength bulkheads aft, which would run from the 02 level to the keel. We requested that the existing bulkheads be relocated to frames 70, 82 and 94, thereby providing a large stern slot through which heavy equipment could be launched or streamed. The resulting after deckhouse was reduced in size as was the center well. This change was approved by BuShips.

We were informed that both hulls forward of the forward deckhouse would be covered to the 01 level. It was suggested that one hull could be used for conventional anchoring and the other for deep anchoring. Calculations revealed that the catamaran should be anchored from a point on its centerline.[7] The frontal wind area presented by the catamaran was very large compared to the GIBBS area. It was determined that the former could be anchored utilizing 3/4-in. diameter, 3 x 19, elevated yield strength wire rope under the same weather conditions that the GIBBS had been anchored satisfactorily on a 5/8-in. diameter, 6 x 19, extra improved plow steel rope. Studies were made to determine if the anchoring could be accomplished from one bow and then the load shifted to the ship's centerline. It was finally decided that a large U-frame would be required to straddle the bows and provide this centerline point

[7] H. C. Beck, Preliminary Calculations and Considerations for Deep Anchoring Proposed Catamaran AGOR-16 (Hudson Laboratories Tech. Memo No. 80, April 20, 1967).

It was proposed that the power plant should consist of two separate plants, one in each hull. They were to be geared diesel drives with variable pitch propellers. Slow speed propulsion would be available by use of one of the four main diesels running at one-third of its rated load. On this basis, we were willing to trade-off the so called quiet propulsion plant, thereby eliminating the gas turbine power unit and proposed auxiliary electric drive.

A preliminary list of handling gear for the catamaran was submitted to BuShips in mid-May 1966. In general, the winches were the same type and rating as specified for the proposed conventional hull AGOR. Deviations from the conventional hull list reflected the difference in configuration presented by the catamaran, as for example, the forward U-frame structure bridging the hulls for bow anchoring, stern handling crane and 25-ton traveling crane mid-ships. This list of handling gear is presented in Appendix D of this report. Preliminary cost estimate of the handling gear alone, including the wire rope and cable, totaled $991,000.

Prior to developing equipment lists, and in spite of the fact that we were not at all sure that the proposed catamaran would be built or configured in the manner that we had discussed with BuShips, we made preliminary layouts of all of the compartments which we felt could be utilized for scientific purposes. This was most useful to us in determining where handling gear should be placed, and accesses should be provided. It was also of great use to BuShips in the determination of costs.

Of great concern to all parties involved were the cost estimates for the ship and its equipage. We had been warned by the Office of Naval Research that there would be no funding available to Hudson Laboratories for outfitting

the ship and that we must ask for everything required as part of the total package. It was our feeling that some compromise might have to be arrived at in order that we get a useful ship with at least the hard core of the scientific suite and handling gear. We prepared an equipment trade-off list for the ship categorizing certain features and equipment as being (a) not essential, (b) equipment required but which could be added later without incurring great additional cost, and (c) items for which substitutes would be acceptable representing a savings.

Elimination of the quiet, low-speed propulsion provided a potential substantial saving in money. Estimates averaged $400,000 on this item alone. Our willingness to eliminate this requirement was based upon information received that the main propulsion diesels would not carbon up when run for lengthy periods at one-third of rated load. The main propulsion plant of the AGOR catamaran now became identical to that of the ASR. Hudson Laboratories recommended the deletion of a seismic profiler which included an onboard amplifier system, readout equipment, and transducers. It was felt that this would reduce the overall cost by about $100,000. Items in category (a) totaled approximately $500,000.

Items which fit category (b) above included the midship's overhead crane system. We recommended that, if this system were to be added later, the supports and the structure should be part of the ship as delivered. Potential cost saving was not developed on this particular item. Wire rope and cable specified in the Handling Gear List could be installed at a later date. Estimated savings in this category were from $95,000 to $100,000. Other items which could be added at a later date included the portable cable-laying well (back tensioning equipment to be installed initially), radar repeater in the

navigation laboratory (savings approximately $20,000), time code generator (savings approximately $5,000), magnetometer (savings estimated $15,000 to $20,000), power amplifiers for driving the acoustic sources (savings about $40,000 -- cooling, power cables, and power distribution cabling to be provided as part of the ship). The items in category (b) totaled close to $250,000.

Category (c) items included replacement of the 3° electronically stabilized fathometer, with an estimated cost installed of more than $300,000, with a mechanically stabilized unit. Several substitutions appeared to be satisfactory. This represented a potential savings of about $240,000. The electronically stabilized unit was specified since it was a major part of the electronic suite provided on the AGS-26. A Mark XIX gyro was required for use with the 3° fathometer and would be unnecessary for the mechanically stabilized unit. It was recommended that the Mark XIX gyro be replaced with a less costly unit representing a saving of about $25,000. A saving of approximately $45,000 could be realized by substitution of various electronic equipment. Total savings represented by all caterogies listed above was over one million dollars.

In addition to the possible deletions and substitutions which would result in savings described above, other substitutions and deletions were suggested. We recommended that the four sea chests be deleted in favor of three instrument wells. We stated that a UQC would be satisfactory rather than a WQC underwater telephone. We requested installation of a satellite receiver and felt that this should not be deleted. In addition, we felt that the laboratory power requirements could be reduced from 300 kW to 100 kW of 440 volt 3 phase power.

Because of lingering doubts about catamarans in general, arrangements were made with Reading & Bates to visit the world's largest catamaran, the S.S. E. W. THORNTON. In June of 1966, the authors together with Mr. H. A. Meier, Project Engineer for the catamaran from the Naval Ship Engineering Center, visited this vessel in the Gulf of Mexico in the area of Tuxpan, Mexico. This was a much larger vessel (8500 tons) than the one we were considering for research use (Fig. 22). It is utilized as a drilling platform and is generally moored in an eight point moor in middle depths of water (1000 ft or so). Discussions with the Master of the vessel revealed that very little experience had been gained in underway operations in rough weather since the vessel had departed its building yard for the station where we boarded her. While moored, however, and during a storm with heavy seas, damage was sustained to both hulls while the ship was held down by her mooring lines. The heavy seas, passing between the hulls, created sealed air pockets which were compressed with the passage of the waves. This pressure buckled the skin and structure of the hulls inboard. To prevent a recurrence of this, additional framing was provided. The hulls of this ship were asymmetrical, but the beam of each hull was quite large in relation to the space between the hulls, and the freeboard to the main deck between the hulls was quite a bit less than that proposed for the research catamaran.

In June 1966, BuShips estimated the cost of the catamaran based on the preliminary characteristics without deletions or trade-offs at $16.0 million. Funding available was $13.5 million. The Chief of Naval Research requested information on the cost breakdown and asked for guidance as to what items could be considered for reduction or deletion to bring the cost estimate within the money available. He asked that consideration be given to the reduction of

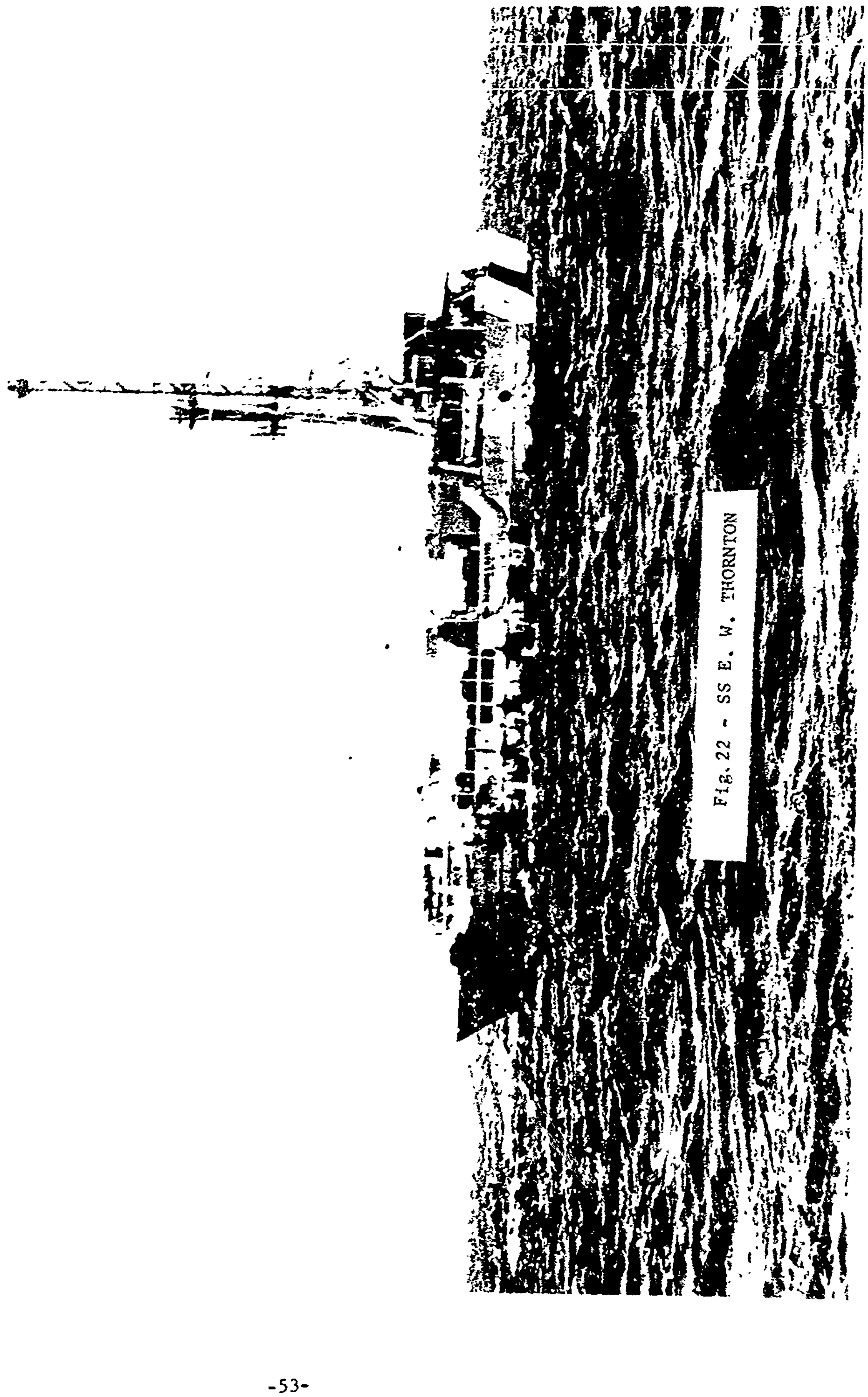


Fig. 22 - SS E. W. THORNTON

the speed of the ship and gross tonnage. He pointed out that commercial maritime specifications were acceptable in most areas of the design in lieu of military requirements.

On August 22, 1966 the Naval Ships System Command responded to the Chief of Naval Research's letter reporting the results of additional studies conducted as an aid in reducing the cost of the catamaran. One proposal that had been examined was to use two, rather than four, diesel engines locating both in the same hull for minimum manning and using an electric drive in each hull. It was reported that the added cost of the electric drive would exceed the savings from using fewer diesels. A second proposal was to use two, rather than four, diesels each in a separate hull. The original sustained speed of 16 knots would be reduced to about 13 knots. Machinery costs would be reduced in the order of $250,000 and there would be no personnel decrease. Consideration was given to the use of two diesels with greater horsepower, one in each hull. This would increase ship speed above the previous scheme, but the cost would be higher and, therefore, initial savings would be less.

It was felt that a 10% reduction of full load displacement would not effect the initial cost. It was reported that commercial specifications were already being used in place of MIL specifications to the maximum extent possible; therefore, no savings could be made in this area.

A refined estimate for the end cost of the catamaran was reported as $17.5 million without the silent ship propulsion feature. The budget for the ship was now stated as $13.5 million. The estimate for scientific electronic hardware was $1.0 million and for handling gear $.8 million. It was further stated that there was a possibility that the allowance of $.4 million for future characteristic

changes might be waived by the Chief of Naval Operations. It was, therefore, recommended that the Chief of Naval Research determine if the equipment and handling gear could be provided as government furnished material. If this could be done, the basic ship could apparently be kept within the ship's construction budget.

Revised characteristics were issued by the SCB on September 26, 1966. The new characteristics called for the same basic hull, propulsion plant and speed. Partial automation of the propulsion plant was specified and many of our recommendations for reduction of, or changes to, equipment were encompassed. Winches, cranes, davits, U-frames, and the electronic suite were no longer included in the characteristics. Only provision for space, weight, foundations, and cabling was to be provided for this equipment. The proposed crew was cut to 11 officers, 2 CPOs and 32 enlisted for a total of 45.

On October 17, 1966 the Naval Ships Systems Command informed the Chief of Naval Operations that the cost of the ship based upon the above characteristics was estimated at $14.8 million for the lead vessel and $13.2 million for the follow-on vessel. It was recommended that the ship be cancelled from the program on the basis that insufficient funding existed for the bare ship.

A full board meeting of the Ship's Characteristics Board was held in late October 1966. The Naval Ship Engineering Center was charged with carrying out feasibility studies for a revised preliminary design to bring the ship cost within the funds available. The Oceanographer of the Navy was charged with the responsibility of budgeting for the scientific, electronic and handling gear. This funding was to be derived from the Navy's operating funds rather than from the ship construction funds.

In its studies, NavSec reduced the beam of each hull from 26 ft to 24 ft.[8] It appeared that the tonnage would be approximately 3000 tons with a draft of 18.5 ft. The waterline length of the revised design was increased to 220 ft without a change in the overall length of the ship. The overall beam of the ship was reduced to 80 ft, thereby reducing the distance between hulls to 32 ft. One main propulsion diesel engine was deleted from each hull. The remaining two engines were capable of propelling the ship at 13.5 knots. A detailed study of propulsion at creep speeds was made and NavSec recommended that one 165 brake horsepower diesel engine be added to each shaft to improve plant operation and reliability at these low speeds. Hudson Laboratories personnel were very unhappy about the reduction in speed to 13.5 knots and, on this basis, ONR requested that the speed be increased to 15 knots. A complete study of propulsion schemes was made by NavSec. Naturally aspirated engines rated at 2400 brake horsepower were finally recommended to provide the 15-knot sustained speed requested. At a later date, slow speed supercharged engines were specified. In addition, one 165 brake horsepower creep engine was provided on each shaft. A 12-ft diameter controllable pitch propeller was selected for the revised design. With this propeller, it will be possible to sustain a speed as low as two knots using one creep engine at its minimum rpm.

M. Rosenblatt & Sons conducted a preliminary electrical load analysis based partly upon information submitted to them by Hudson Laboratories which covered our past experience in oceanographic ship operations. In order to assist them, we also defined four modes of operation, each requiring various degrees of acoustic quieting. These definitions were as follows:

---

[8]Naval Ship Engineering Center, <u>T-AGOR-16, Preliminary Design Summary, Oceanographic Research Ship</u>, SCB Project No. 726.67, 28 June 1967, prepared by M. Rosenblatt & Sons, Inc., New York, New York.

1. Cruising: Ship underway in normal operation; no acoustic isolation of main plant contemplated.

2. Creeping: Ship underway up to 4 knots. Hotel facilities, reefers, air conditioners, pumps and machinery operating normally. Spectrum level at 100 cycles equivalent to sea state 3 at 6000 ft for an indefinite amount of time.

3. Semi-Quiet: Ship dead in water. Hotel facilities, reefers, air conditioners operating normally. Spectrum level at 100 cycles equivalent to a sea state zero at 6000 ft for an indefinite amount of time.

4. Quiet: Ship dead in the water. Minimum hotel facilities, reefers and air conditioning compressors off. Spectrum level at 100 cycles equivalent to sea state zero at 3000 ft for 12 hours, with a four hour recovery period. This period can be increased to 20 hours on Quiet by running the reefers to 10^{o} below normal operating temperature before starting; however, it is limited to only 48 hours by the potable water supply.

The 300 kW shock mounted gas turbine generator proposed for scientific requirements initially was deleted. Instead, two 75 kW, 450 volt, 3 phase, 60 cycle shock mounted diesel generators were specified. They were to be installed in a compartment well above the waterline. One of these generators was to supply

scientific power and the other to supply essential services under quiet ship conditions. Three 350 kW, 450 volt, 3 phase, 60 cycle diesel generators were to be provided for ship's service and one 60 kW, 450 volt, 3 phase, 60 cycle diesel generator was to be provided to serve as the ship's emergency generator.

NavSec decided to reduce the number of scientists which would be accommodated on board from 30 to 25. This resulted in a reduction in the crew of one man. The general feeling at Hudson Laboratories was that we certainly favored the reduction of costs, but we felt that there were occasions when more than 25 people would be required on board. We, therefore, requested that five emergency berths be provided and specifically requested that the crew not be increased nor the reefers or other stowage compartments increased in size to accommodate these five scientists. Agreement was finally reached on this point. The forward deckhouse contains all living quarters and hotel facilities. The scientific berthing is provided on the 01 deck in double staterooms, except for the Chief Scientist's stateroom which is a single room. All berths are lower berths.

During the period that NavSec was revising the preliminary design to bring costs within the budget, the Hudson Laboratories technical personnel were working with NavSec, the Program Manager's Office, and M. Rosenblatt & Sons to develop interior layouts of the laboratories, equipment lists, power budgets, and general layouts which were compatible with the structural and operational requirements of the ship. Hudson Laboratories also maintained a continuing liaison with MSTS to keep them informed of developments in areas in which they had a major interest, and to insure that their interests and ours were compatible. We were allowed to do this through the good offices of Mr. Gary Jayne of the Instrumented Ships Project Office (PMS-5), Mr. J. J. Kleinheinz, Project Director for NavSec, and Mr. Richard Venable of Naval Ships Systems Command.

In a departure from normal practice, we were allowed to work directly with the Naval architects, M. Rosenblatt & Sons, who were located conveniently in New York City. This led to considerable savings in both time and money when compared to the usual procedure of reviewing the Naval architectural plans after they were completed and making comments requiring subsequent changes. We were allowed to provide the architect with our preliminary drawings and discuss our needs prior to his preparation of drawings and specifications, with which we concurred. In order for such an arrangement to work, a true spirit of cooperation must exist, and it should be reported that the Rosenblatt organization cooperated in every way. We, in turn, had to provide timely information, drawings, specifications, and equipment lists.

Preliminary plans for the forward U-frame bridging the hulls were developed jointly. The midship's traveling crane was abandoned in favor of a centerline crane similar to the stern crane which can be layed flat to act as a beam and fairlead for handling equipment through the center well. This crane can be used conveniently for loading in the center well area and through hatches to the laboratories.

VII GENERAL ARRANGEMENT OF APPROVED DESIGN

On March 15, 1967 the approved characteristics for the catamaran research ship were promulgated by the Chief of Naval Operations. These characteristics as amended on 5 March 1968 are included in this report as Appendix E.

Figure 23 is a much publicized artist's version of the AGOR-16. Shown in the photograph of the model (Fig. 24) are changes to the 02 level of the after deckhouse, removal of the doors on the 01 deck starboard hull serving the starboard U-frame forward, replacement of the small U-frame forward between the hulls with a large bridging frame and general updating of the configuration.

Figure 25 is a compilation of scientific areas, showing a comparison of the AGOR-16 to the USNS GIBBS. The areas available on the catamaran are greater in every category; the laboratory space is more than three times that available on the GIBBS, and storage, miscellaneous spaces, and weather deck areas are considerably larger. In laying out the scientific areas, it was readily apparent that Hudson Laboratories could not effectively use all of the space initially available to it. However, far from representing a waste of space, these additional areas represent great future potential.

General arrangements of the hold and first platform are not presented in this report since they are of limited interest from the scientific standpoint. Figure 26 is an arrangement plan of the second deck. In general, most of the area forward of frame 52 is reserved for MSTS operations and crew berthing. The starboard hull forward has one area for scientific stowage which lies beneath a material handling area. The officers' laundry in the port hull in the vicinity of frame 50 is to be shared with the scientific group and is a self-service facility. The starboard hull aft of frame 52 contains a scientific

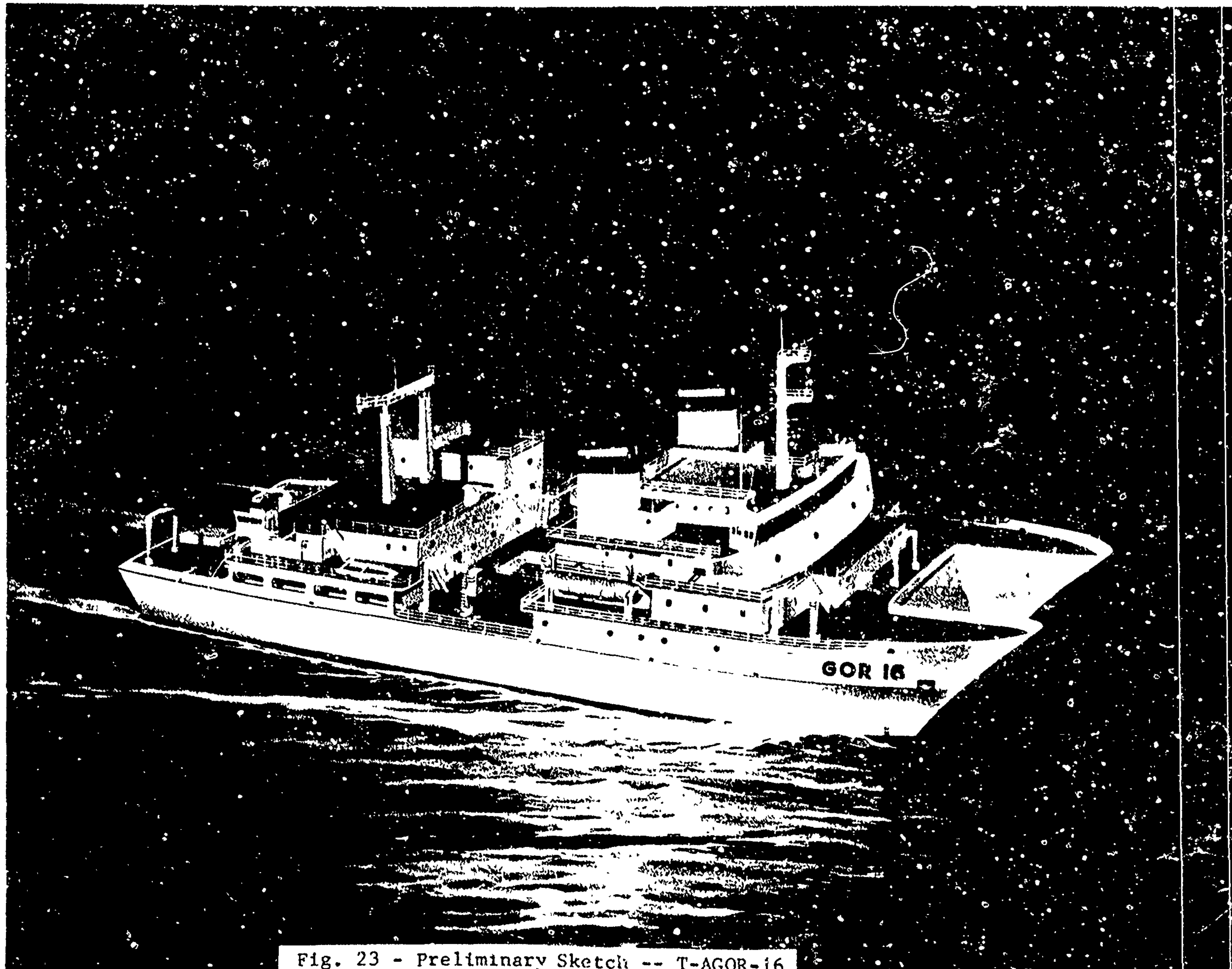


Fig. 23 - Preliminary Sketch -- T-AGOR-16

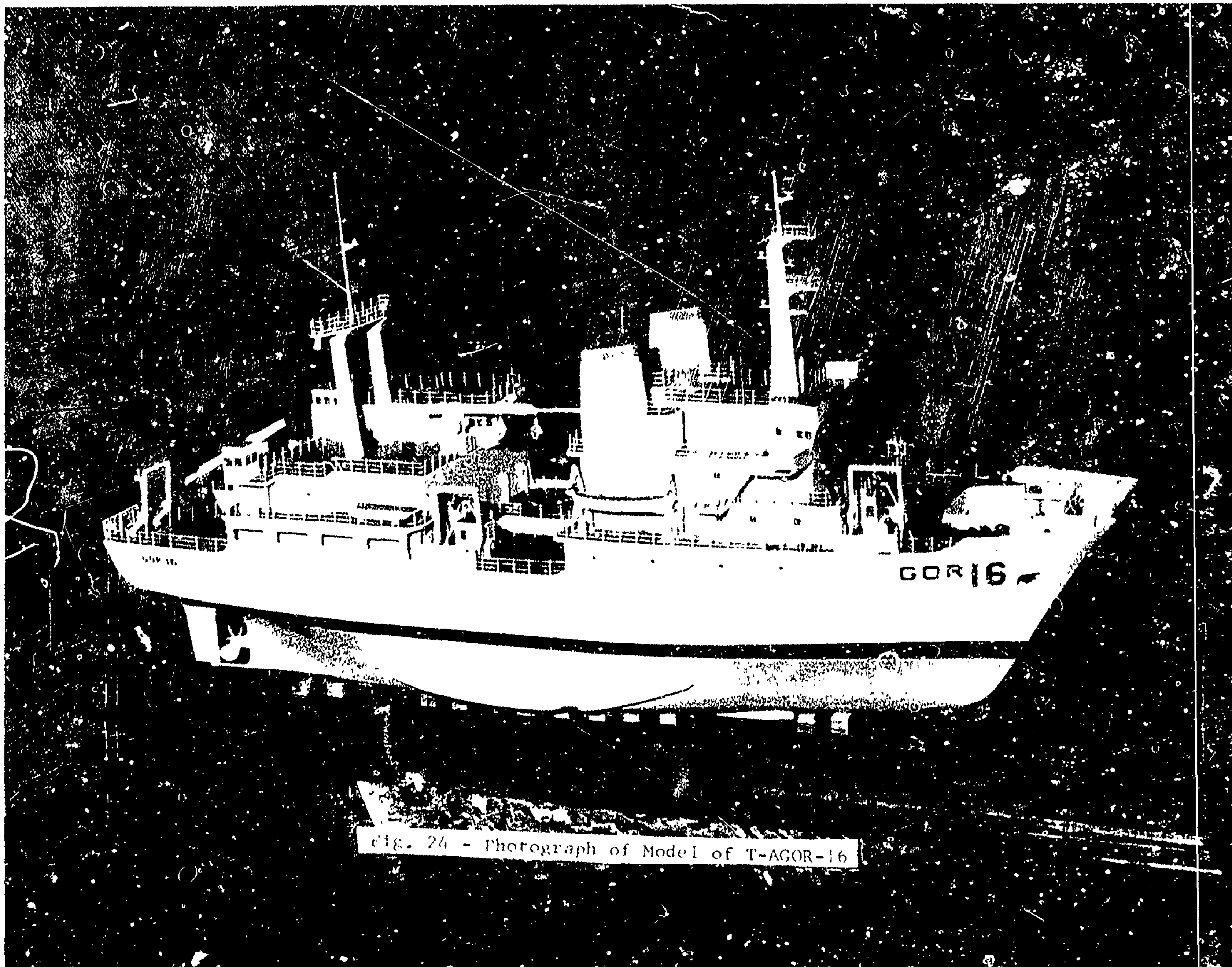


Fig. 24 - Photograph of Model of T-AGOR-16

T-AGOR-16

SCIENTIFIC AREAS

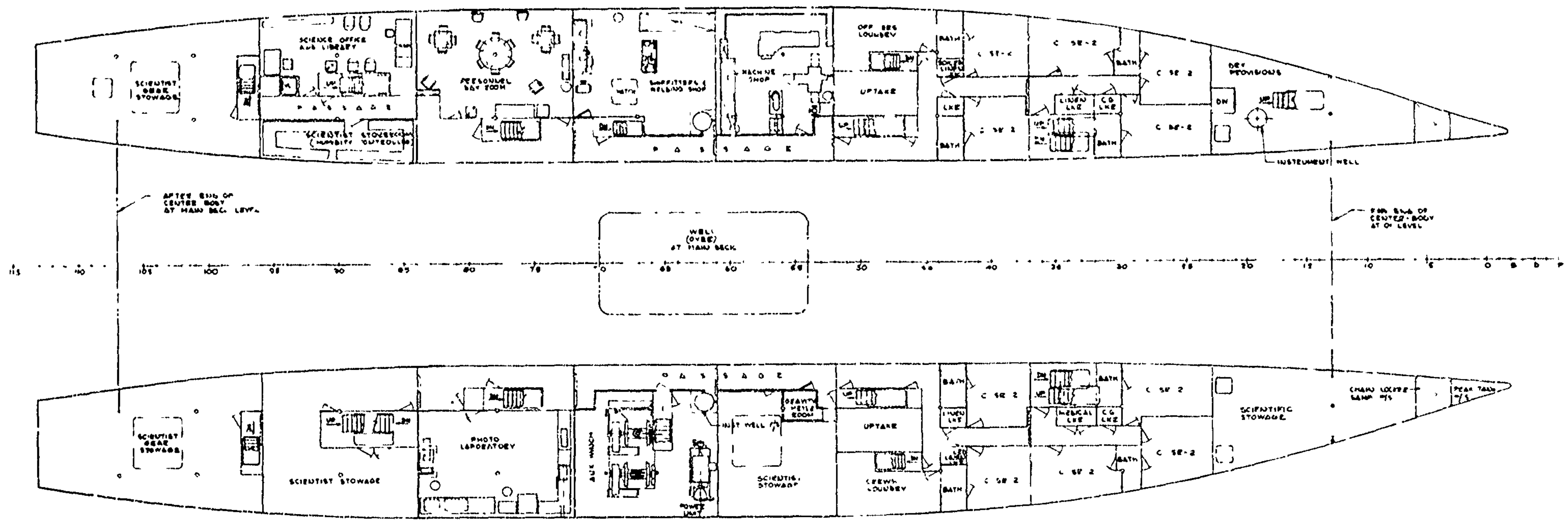
COMPARTMENT	DECK	FRAME	AREA FT²	LAB TOTAL	SCI. SPACE MISC TOTAL	WEATHER DK. TOTAL
WEATHER DK	03	72-96	988			998
DEEP SEA ANCHORING RM	02	72-96	868			
WEATHER DK	"	12-96	1743			1743
WEATHER DK	"	17-23	300			300
SCI RADIO RM	01	86-96	280	280		
RESEARCH CONTROL CENTER	"	72-84	264	264		
MAIN RECORDING LAB	"	"	720	720		
COMPUTER RM.	"	86-96	400	400		
DATA PROCESSING LAB #1	"	"	200	200		
FILE STOW. & OFFICE	"	89-96	84		84	
ELECT. SHOP #1	"	77-84	138		138	
ELEC. SPARE PARTS STOW	"	72-77	117		117	
FWD DEEP SEA ANCHORING DK	"	10-17	715	(WEATHER	DK)	715
FANTAIL-WEATHER DK-	MAIN DK	96-115	1400			1400
SCUBA GEAR LKR.	"	100-104	48		48	
PERSONNEL DAY RM #2	"	86-96	200			
DATA PROCESSING LAB #2	"	80-84	136	136		
ELECTRONICS SHOP #2	"	72-80	236	236		
RADIO SERVICE ROOM	"	91-96	50		50	
MECH ENG. SHOP	"	86-96	600	600		
ELECTRONICS LAB	"	72-84	704	704		
ME CAL. & TEST LAB	"	89-96	140	140		
WET LAB	"	72-84	312	312		
MIDSHIP - WEATHER DK-	"	52-72	2100			2100
MIDSHIP WELL	"	54-10	512	(32 × 16 WELL)		312
FWD DEEP SEA ANCHORING RM	"	13-23	522			
FWD AUX WINCH RM.	"	13-23	589			
SCI. DK GEAR LKR	"	96-104			188	
SCI GEAR STRM. PT HULL	2ND DK	96-107	458		358	
" " " STBD "	"	96-113	554		534	
" STRM. (HUMIDITY CONTROL)	"	84-96	168		168	
" " STBD HULL	"	"	390		390	
" OFF. & LIBRARY PT.	"	"	200			
PERSONNEL DAY RM PT	"	72-84	366			
PHOTOGRAPHIC LAB. STBD	"	"	384	384		
GENERAL WORKSHOP	"	61-72	352		352	
MACHINE SHOP	"	52-61	288		288	
MIDSHIP AUX WINCH RM	"	61-72	262			
SCI STOREROOM	"	52-61	250		258	
SCI GEAR STOREROOM	"	6-23	370		370	
GRAVITY METER RM	"	53-56		24		
DEMOLITION CHARGE STOW	1ST PLATF	84-96	360		360	
SCI STOREROOM	"	72-84	416		418	
ELECT. REPAIR PARTS STR.	"	79-84	110		110	
" " "	"	79-84	110		110	
SONAR TRANSDUCER RM	TANK TOP	23-37	320			
			TOTALS SQUARE FT	4400	4035	7758

U.S.N.S. GIBBS

SCIENTIFIC AREAS

COMPARTMENT	DECK	FRAME	AREA FT²	LAB TOTAL	SCI. SPACE MISC TOTAL	WEATHER DK. TOTAL
WINCH RM. (STOW DRUMS)	1ST PLATF	121-131	510		510	
WEATHER DK	01 DK	101-114	760			760
NAVIGATION LAB	MAIN DK	95-105	250	250		
AUX. ELECT LAB	01 DK	78-84	24	84		
FWD DEEP SEA ANCHORING DK	01 DK	29-45	230	WEATHER	DK	230
FANTAIL-WEATHER DK-	MAIN DK	114-AE	2650			2660
SCI DATA LAB		105-114	65	165		
LABORATORY "B"	"	95-105	190	190		
MECH ENG. LAB	"	105-114	238	238		
LABORATORY "A"	"	87-96	448	448		
WEATHER DK	"	14-29	480			480
DAY-ROOM & (CONFERENCE)	2ND DK	112-121	221		221	
DARK ROOM	"	97-103	77	77		
U FRAME HYD EQUIP RM	"	143-148	60		60	
SCI MACHINE SHOP	"	121-131	340		340	
SCI STORES	"	141-152	160		160	
SCI GEAR STOREROOM	"	121-131	336		335	
MAGAZINE	1B.	125-131	132		132	
"	"	"	132		132	
"	"	121-125	96		96	
LAB STOREROOM	1ST PLATF	24-44	480		480	
" STORES	1B.		100		100	
			TOTALS SQUARE FT.	1452	2572	4130

Fig. 25 - Comparison of Scientific Areas
T-AGOR-16 and USNS GIBBS



PLAN-VIEW
AT
SECOND DECK

Fig. 26 - General Arrangement Plan
Second Deck - T-AGOR-16

stowage area with a large overhead hatch in the main deck. This hatch is serviced by the midship rotating crane. A small gravity meter room is provided for future installation of equipment. It is located as near to the center of gravity of the ship as possible. An auxiliary winch unit is located aft of the scientific stowage area. A full description of this unit and of all other handling gear will be given in a later section of this report. An instrument well is located in this area and runs from the main deck through the bottom of the ship. Two other wells are provided, one in the port hull at the same frame and one forward in the port hull at about frame 19. These wells are located orthogonally and are equally spaced from the centerline of the ship. They are identical in diameter and specification to the wells provided on the USNS MISSION CAPISTRANO (T-AG 162) for its dynamic position keeping system.[9] In the case of the catamaran, it is proposed that an acoustic tracking and/or acoustic locating system will be installed eventually similar to the AC Defense Research Laboratories of General Motors Corporation equipment installed on the USNS MISSION CAPISTRANO. Each of these wells is provided with a removable bottom seat which supports a hydrophone arm. The hydrophone head is extended well below the skin of the ship. Each of these wells will be provided with a bolted cover plate. They can be used for deploying instrumentation other than hydrophones.

In the starboard hull aft of the auxiliary winch room, an extremely commodius photographic laboratory is provided. This room is quite a bit larger than is required and additional equipment may be installed at a later date.

---

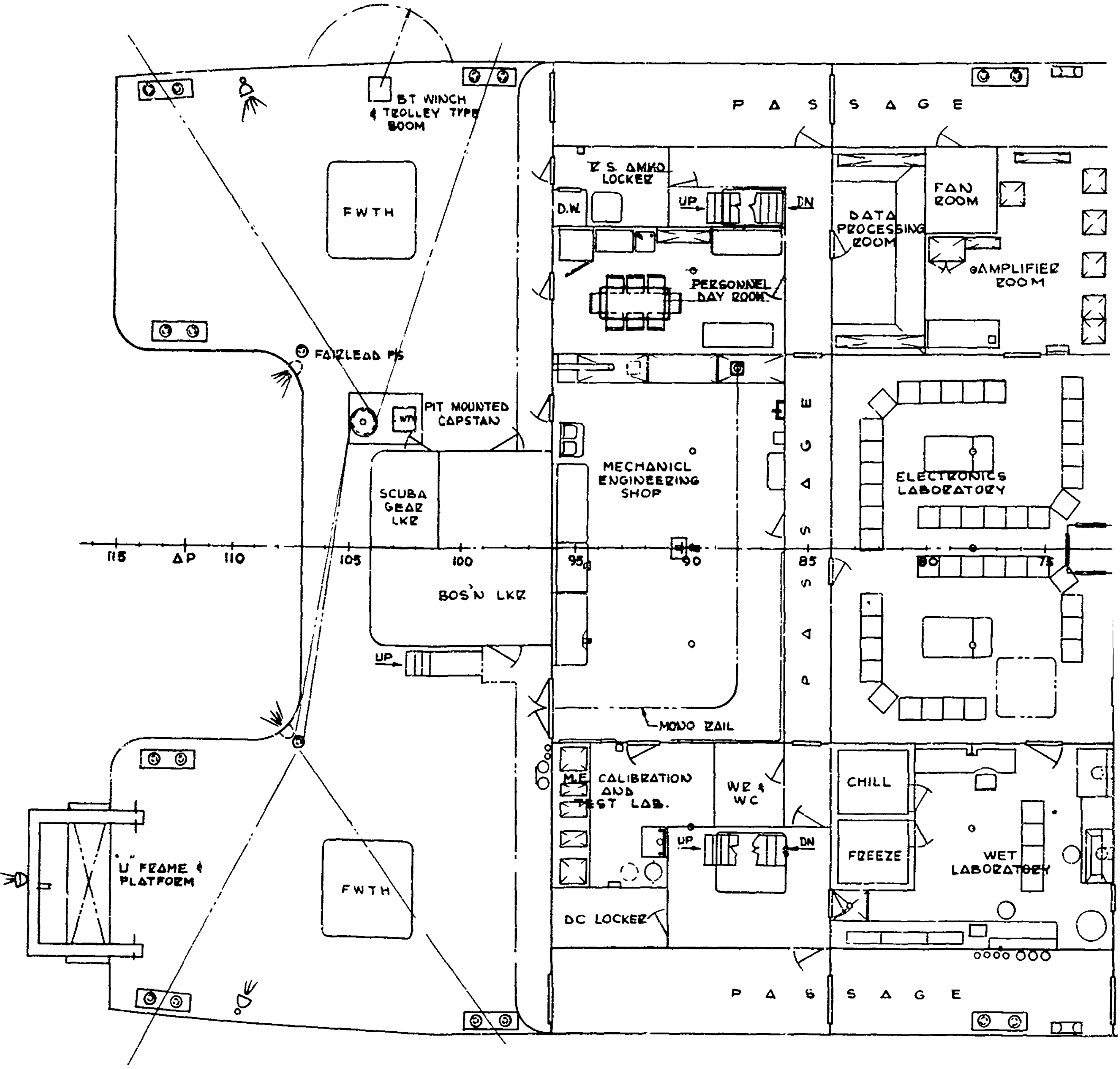
[9]H. C. Beck and J. Ess, A Dynamic Position Keeping System Installed Aboard the USNS MISSION CAPISTRANO (T-AG 162), Volume I: Preliminary Design Consideration and Installation (HL Artemis Report No. 65, Vol. I, August 1966).

Aft of this space, two very large scientific stowage areas are provided. The forward compartment can be loaded using either of the rotating cranes through the ladder well. Double access doors are provided, and it is proposed to equip the overhead of this space with monorails for distribution of heavy gear. The aftermost of the two scientific stowage gear rooms is serviced by a large overhead hatch which can be loaded using the stern crane. It is proposed to equip this compartment and an equivalent compartment in the port hull with monorails. All stowage areas will be equipped with tie-down rings, battens, tie-down pipes, etc.

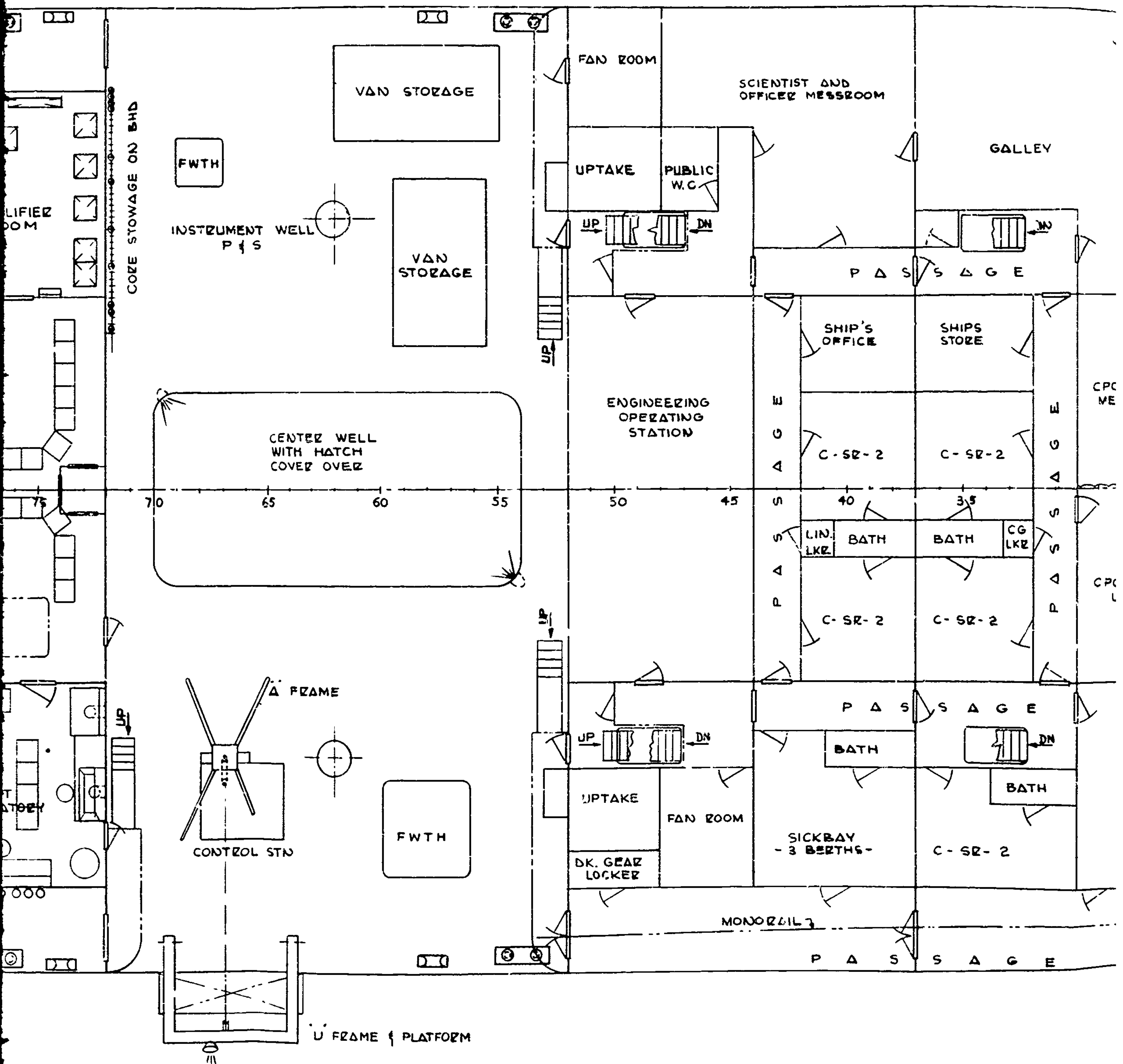
The port hull will be provided with a fairly large machine shop, ship fitting and welding shop. These areas are to be shared with the ship's crew, but maintenance and upkeep is to be provided by MSTS personnel permanently assigned to the ship.

A personnel day room, scientific office and library combination, and a humidity-controlled scientific storeroom utilize the remaining space in the port hull. It is proposed to store magnetic tapes, computer punch cards, and other humidity sensitive materials in this storeroom. Fore and aft accessibility is quite good on this deck with an inboard passageway running most of the length of each hull. Vertical accessibility for personnel and equipment is also satisfactory.

Figure 27 is a general arrangement plan of the main deck of the catamaran. This deck is a weather deck from frame 52 to frame 72 and from frame 96 aft. Chain lockers for the conventional ship's anchoring and also for the scientific deep sea anchoring are provided forward in each hull. A large traction winch room is provided, straddling the centerline forward, and an auxiliary winch room is provided in the starboard hull in the same general area. Hatches in the deck


BT WINCH
& TROLLEY TYPE
BOOM
FWTH
FAIRLEAD P/S
PIT MOUNTED
CAPSTAN
SCUBA
GEAR
LKR
BOS'N LKR
UP
"U" FRAME &
PLATFORM
FWTH
115
AP
110
105
100
95
90
85
80
75
PASSAGE
SS AMMO
LOCKER
D.W.
UP
DN
PERSONNEL
DAY ROOM
MECHANICL
ENGINEERING
SHOP
MONO RAIL
M.E. CALIBRATION
AND
TEST LAB.
WR &
WC
UP
DN
DC LOCKER
PASSAGE
DATA
PROCESSING
ROOM
FAN
ROOM
AMPLIFIER
ROOM
ELECTRONICS
LABORATORY
CHILL
FREEZE
WET
LABORATORY
PASSAGE

A



VAN STORAGE
FWTH
CORE STOWAGE ON BHD
LIFIER
OOM
INSTRUMENT WELL
P & S
VAN STORAGE
FAN ROOM
SCIENTIST AND OFFICER MESSROOM
GALLEY
UPTAKE
PUBLIC W.C.
UP
DN
PASSAGE
SHIP'S OFFICE
SHIPS STORE
ENGINEERING OPERATING STATION
CENTER WELL WITH HATCH COVER OVER
C-SR-2
C-SR-2
75
70
65
60
55
50
45
40
35
LIN. LKR
BATH
BATH
CG LKR
C-SR-2
C-SR-2
PASSAGE
PASSAGE
'A' FRAME
CONTROL STN
FWTH
UP
DN
BATH
BATH
UPTAKE
FAN ROOM
SICKBAY - 3 BERTHS -
C-SR-2
DK. GEAR LOCKER
MONORAIL
PASSAGE
'U' FRAME & PLATFORM

B

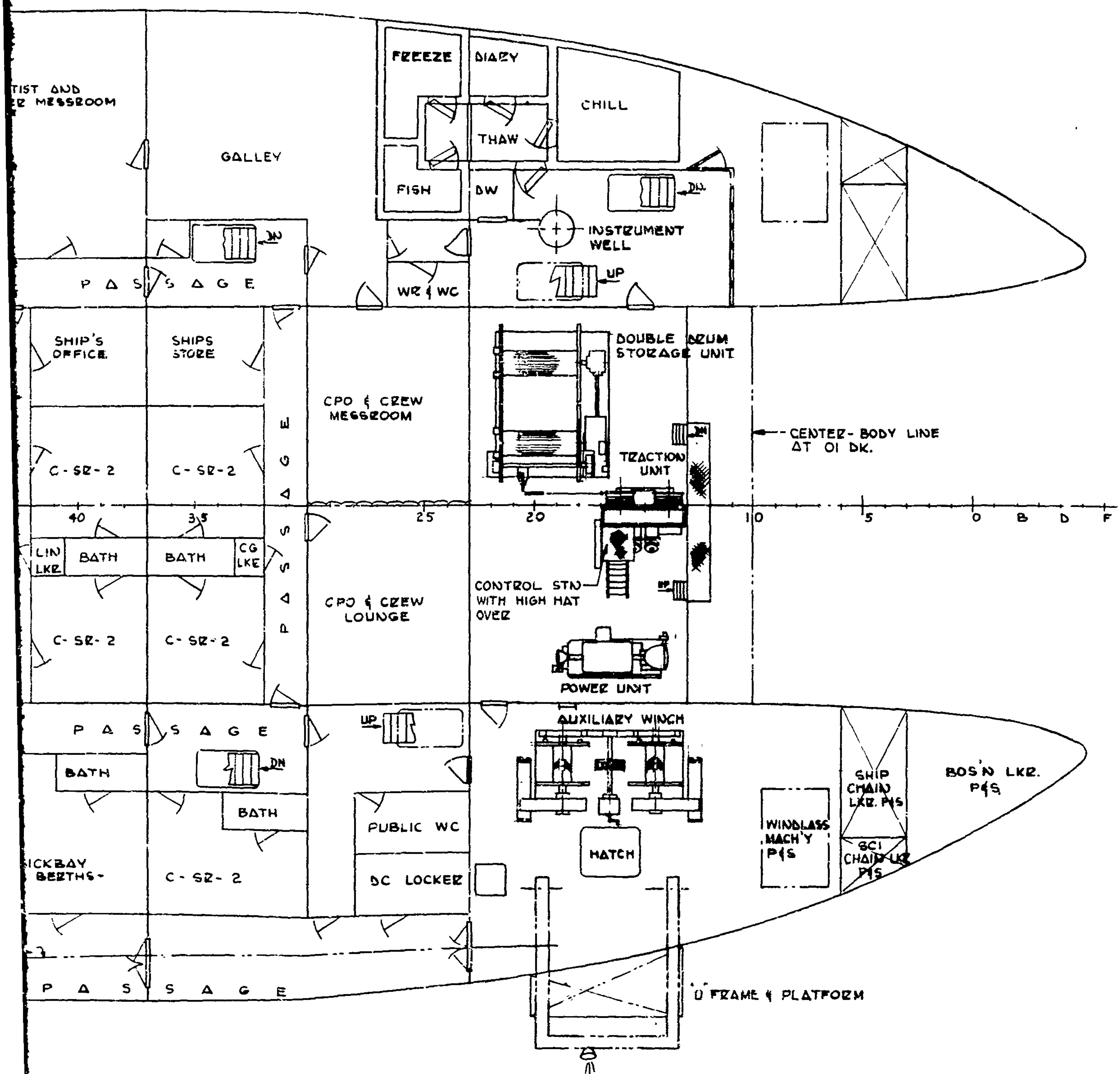


Fig. 27 - General Arrangement Plan
Main Deck - T-AGOR-16

C

and overhead of this latter space service a stowage compartment below. Equipment can be hoisted through these hatches by means of the U-frame mounted above on the 01 deck. A monorail is provided in the overhead of the starboard passageway for purposes of moving equipment from the center of the ship forward to the auxiliary winch room. The balance of the forward deckhouse is used for hotel facilities and ship's operations areas, such as the central engineering operating station.

A 32-ft x 16-ft center well is provided amidships. A folding hatch cover will be provided and will be opened and closed using one of the scientific winches. Services for portable scientific vans are provided on the main deck, midship area on the port side. A control station, fairleads, U-frame, and platform are mounted in the midship area on the starboard side to be used in conjunction with the auxiliary winch located below.

The after deckhouse is basically restricted to scientific use. A 32-ft x 24-ft electronics laboratory is provided, straddling the centerline of the ship. A power amplifier room is located adjacent to this laboratory with access via an arched opening. A wet laboratory is adjacent to the electronics laboratory over the starboard hull and is to be equipped with large freeze and chill compartments. A large mechanical engineering laboratory with adjacent calibration and test facilities is provided in the after deckhouse. In addition, a personnel day room, data processing room, ready service ammunition locker, scientific boatswain's locker and scuba gear locker are provided. It should be mentioned that this plan has been revised. The day room has been interchanged with the mechanical engineering calibration and test laboratory, since Coast Guard regulations prohibit having ammunition handling areas adjacent to personnel habitation areas.

The fairly spacious open deck area at the fantail contains two large loading hatches, one in each hull, for servicing the stowage compartments below. A stern slot is provided for the launching of gear and a stern U-frame and platform are provided for the starboard hull, servicing the after auxiliary winch which is mounted on the 02 deck. A BT winch and boom are located over the port hull aft.

Figure 28 is the general arrangement plan of the 01 deck of the ship. This is the weather deck of the ship forward of the forward deckhouse. A large U-frame straddling the hulls is provided forward. Conventional and deep sea anchor and chain handling gear is provided on both hulls. Control stations for the forward traction winch and forward auxiliary winch are provided. These control stations have good visibility to the U-frames and the overboarding sheaves that the winches serve, and provide for physcial accessibility to the winches themselves. The remainder of this deck in the forward deckhouse is utilized for hotel facilities for the scientific party and for a few members of the crew.

The after deckhouse is again reserved primarily for scientific use. A main electronic recording laboratory is provided, which is identical in size to the electronics laboratory below it on the main deck. A hatch is provided in the deck of the main recording laboratory in order that equipment may be lowered to the laboratory below. The rotating crane servicing the midship area can be utilized for loading through a hatch in the overhead of this laboratory and then through the hatch in the deck. Electronic spare parts stowage and a repair shop are provided adjacent to the main recording laboratory. A navigation laboratory, scientific radio room, computer room, data processing area and small office take up the remainder of the deckhouse on this level. A 16-ft Boston whaler is provided for scientific use.

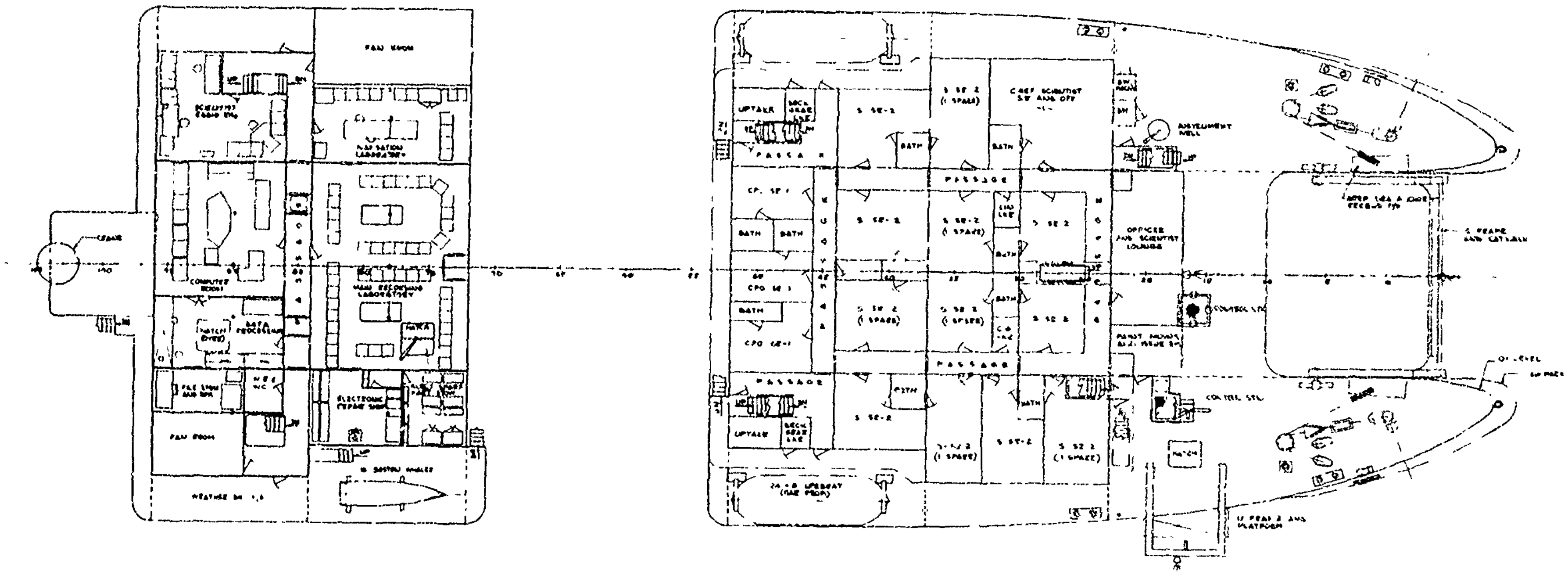


Fig. 28 - General Arrangement Plan
01 Deck - T-AGOR-16

A partial deckhouse is provided on the 02 level atop the after deckhouse on the port side. This is shown in Fig. 24. The after inboard corner of this deckhouse has a control station for operating the after traction winch and the after auxiliary winch, components of which are located within this deckhouse. An operator has good visibility for operating these winches when they are fairled either aft through the after crane or through the after U-frame in the starboard hull or forward through the forward rotating crane. Another winch operating station is provided in the inboard forward corner of this same deckhouse overlooking the center well. A small enclosed control stand is located over the starboard hull aft on the 02 deck for control of main propulsion when streaming gear aft.

Figures 29 through 33 are additional photographs of the model of the subject vessel. The after mast is a dual structure with an internal ladder provided in one leg for access to a scientific antenna platform. A dual leg structure was used since fore-aft access is required along the centerline for fairleading of cables to the two cranes from the winch traction unit which is mounted between the legs of the after mast (see Fig. 29). An after range light was required on the centerline of the vessel and an offset single leg structure aft would require a crossarm at the top to provide this light on the centerline.

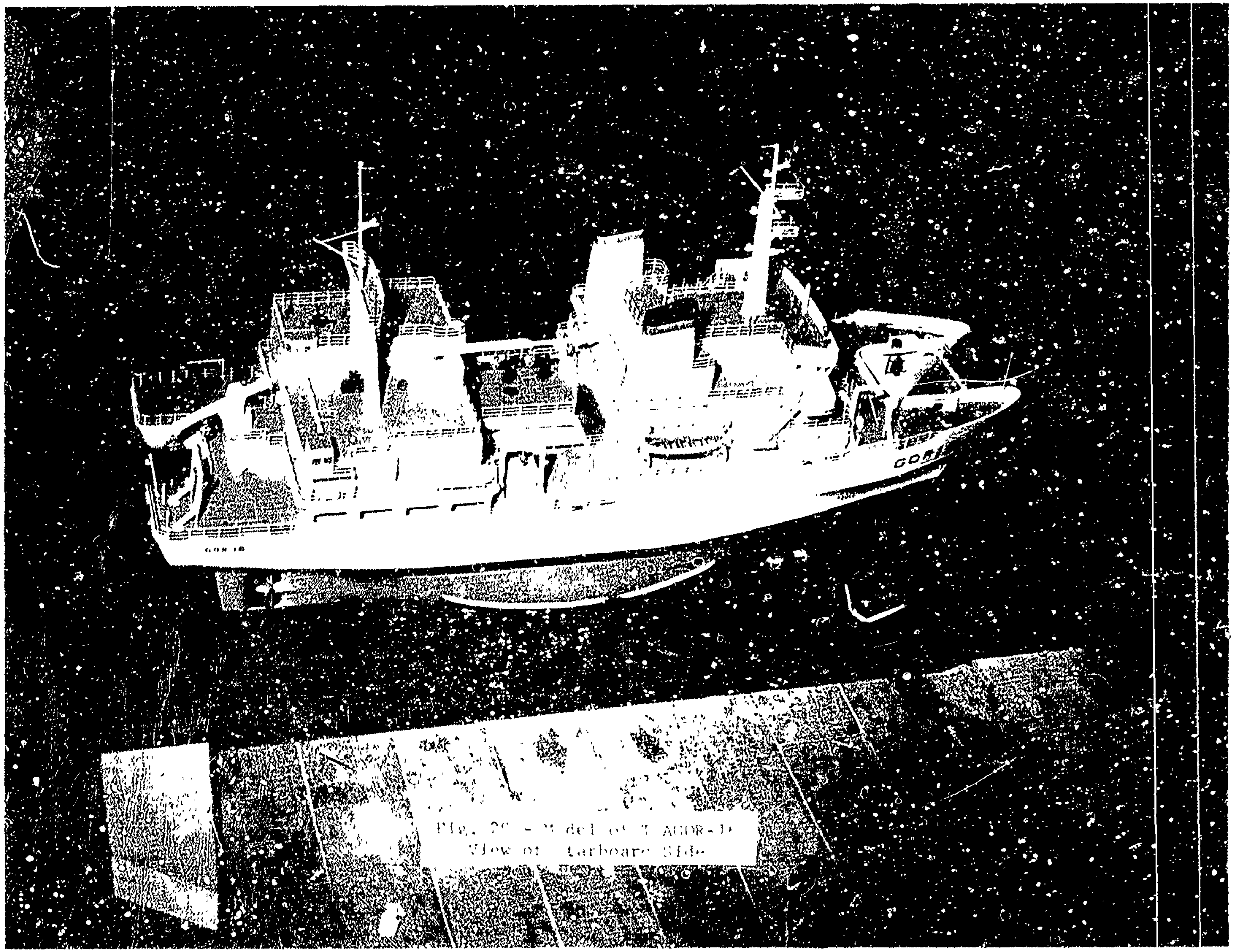


Fig. 26 - Model of T-AGOR-D
View of Starboard Side

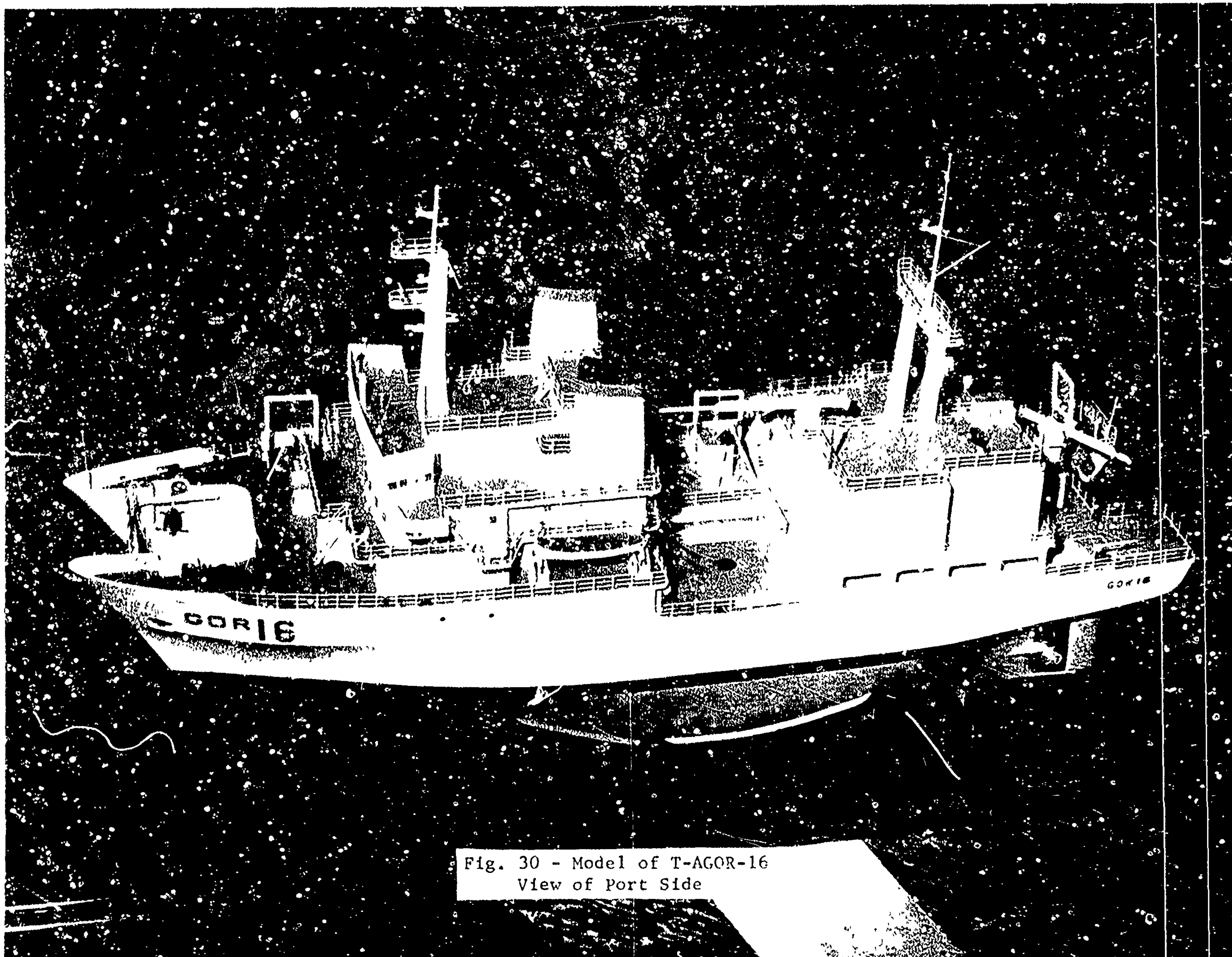


Fig. 30 - Model of T-AGOR-16
View of Port Side

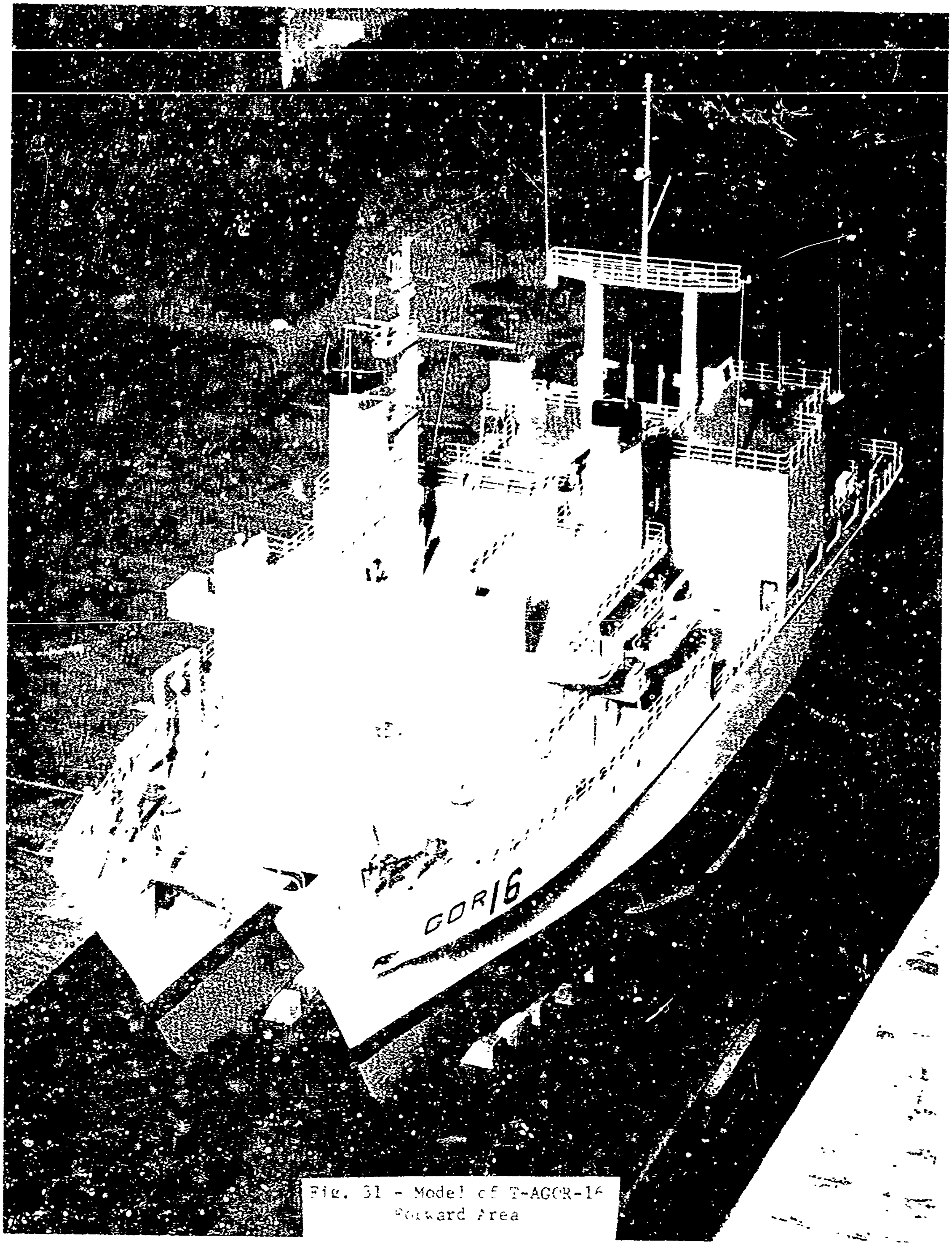


Fig. 31 - Model of T-AGOR-16
Forward Area

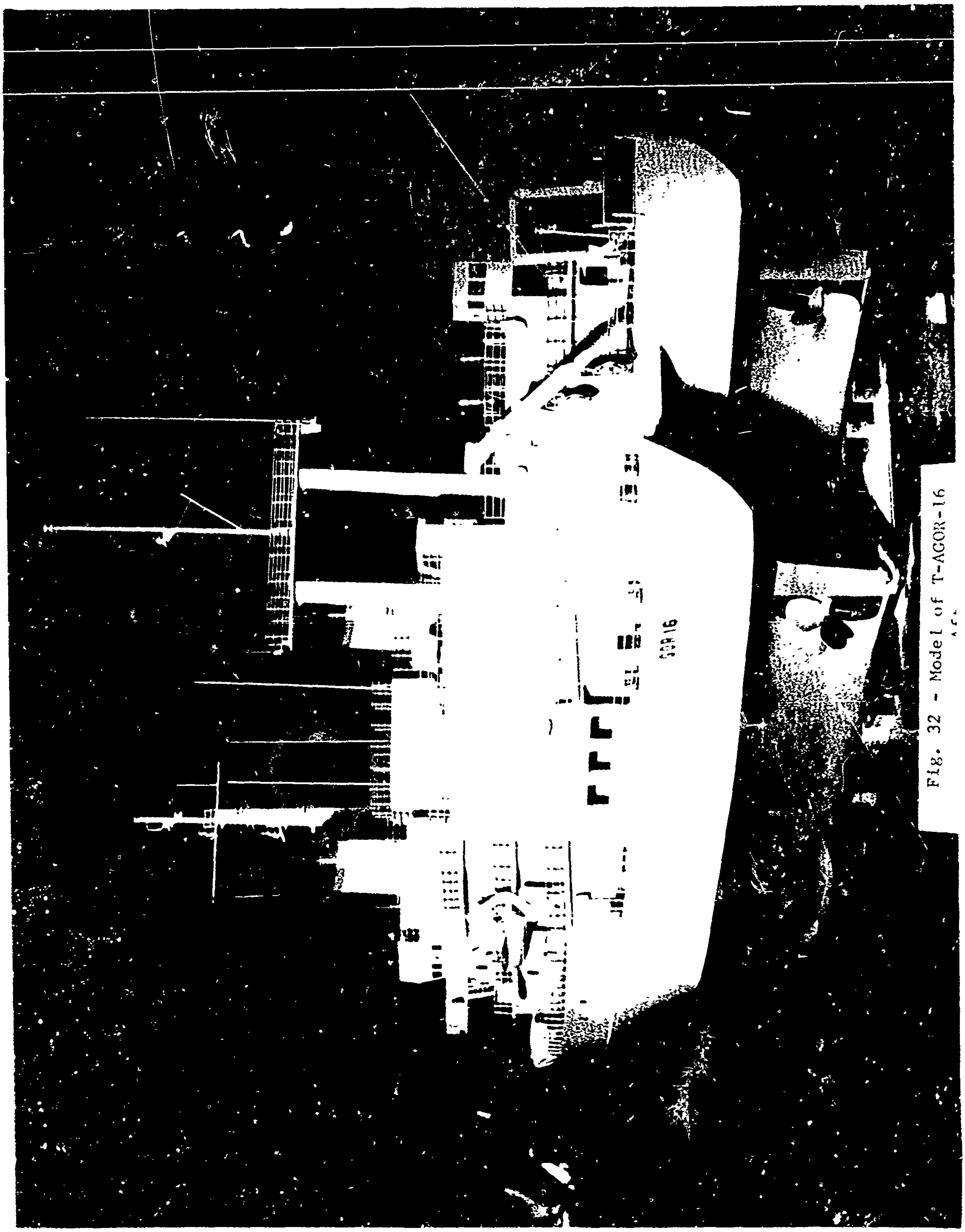


Fig. 32 - Model of T-AGOR-16 Aft

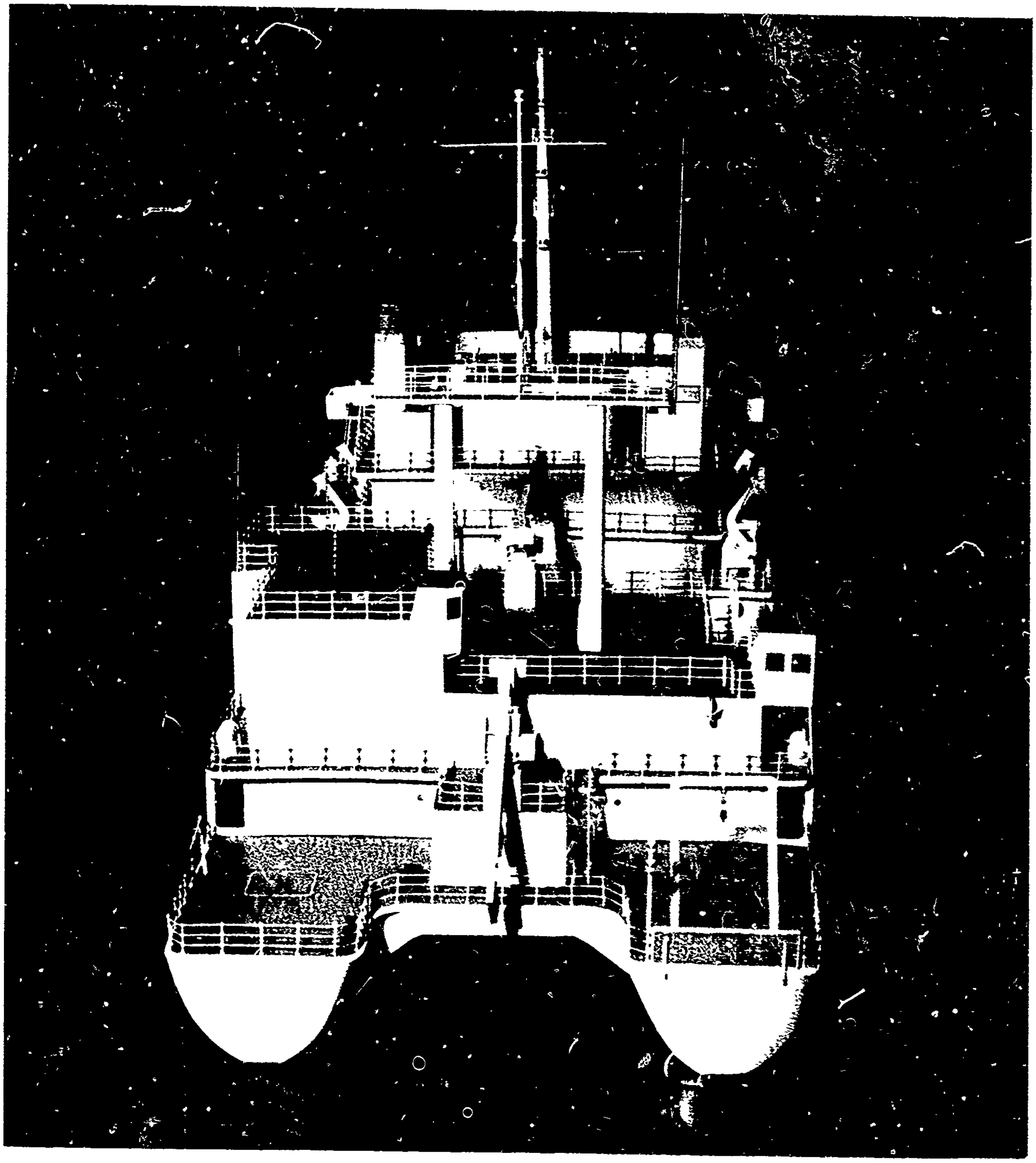


Fig. 33 - Model of T-AGOR-16
Aft

VIII REVIEW OF DETAILED COMPARTMENT LAYOUTS, T-AGOR-16

A. Second Deck

1. Machine Shop

The AGS-26 machine shop was used as a guide in laying out the catamaran's shop. The details of the arrangements on the catamaran are shown in Fig. 34. A list of the equipment in this compartment follows:

MACHINE SHOP

Quantity	Description	Drawing, NAVSHIPS No. and Commercial Equivalent or Equal
1	Tool shelf, metal	
1	Shelves and tool board, metal	
1	Tool cabinet	Equipto Co. No. 70-8
1	Lathe, engine, 19 in. x 42 in. centers, complete with equipment, attachments and accessories	LeBlond Co. "Regal"Model No. 17E5
1	Grinder, bench, 1/2 HP with drill grinding attachments	Rockwell-Delta Co. No. 23-200, 7 in.
1	Milling machine, with one chuck for Model K universal spiral dividing head and complete with equipment, attachments and accessories	Kearney & Trecker Co. Model 205-SA
1	Waste can, oily, galvanized steel, with hinged cover, Type I, Size C	RR-C-114
1	Drill press, floor type, 20 in., round column, 1 HP	Rockwell-Delta Co.
1	Hydraulic press, 25 ton, hand operated	K. R. Wilson, Inc. Model 37-R

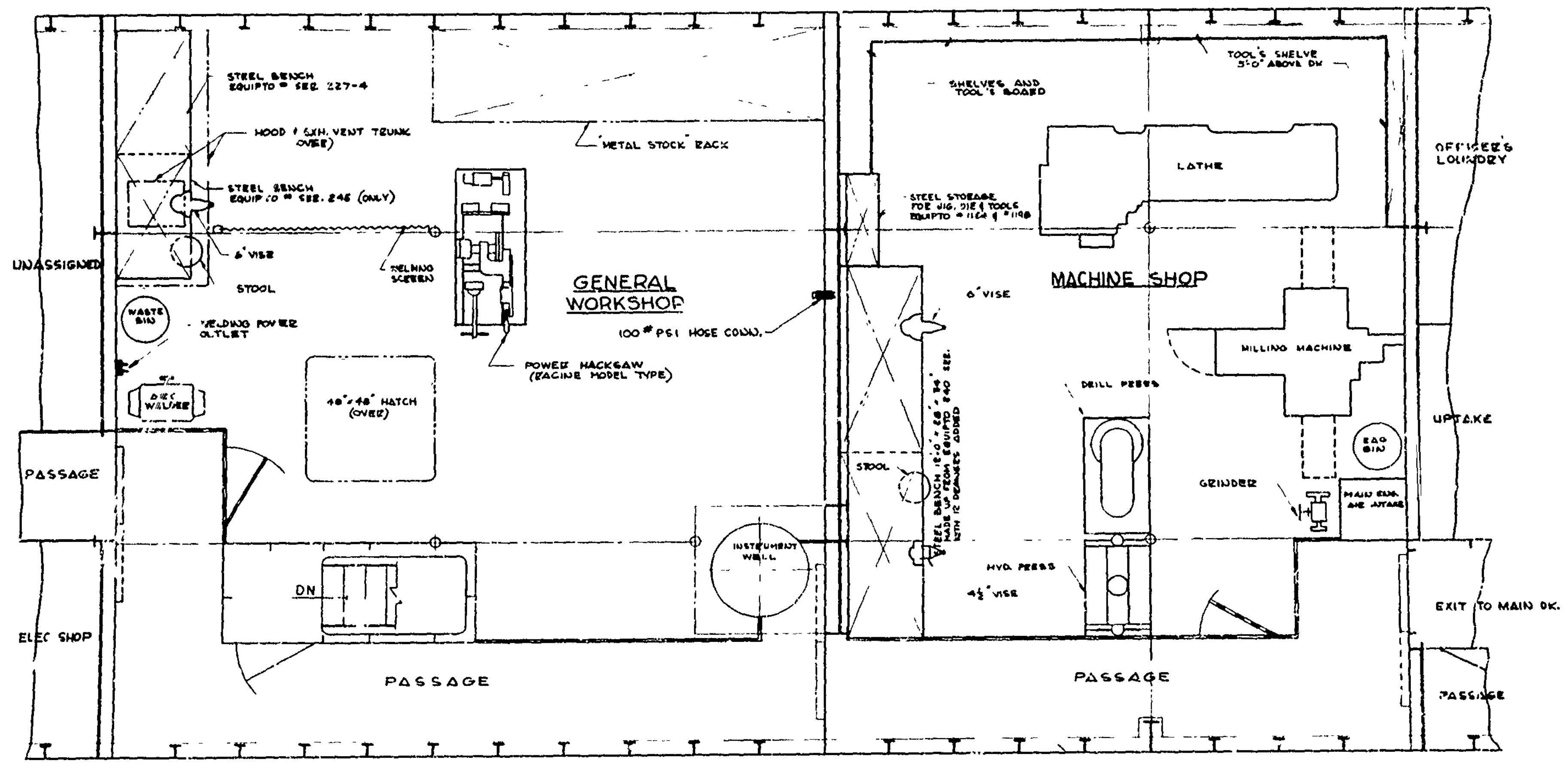


Fig. 34 - Shipfitting, Welding and Machine Shop

MACHINE SHOP (Continued)

Quantity	Description	Drawing, NAVSHIPS No. and Commercial Equivalent or Equal
1	4-1/2 in. vise, bench and pipe	L. S. Starret Co. Cat. No. 8
2	Steel bench, 4 ft long x 28 in. wide x 34 in. high (6 drawers added)	Equipto Co. 240-4 and 240-4A
1	Stool, steel	Jamestown Metal Co. No. 14
1	Vise, machinist, 6 in.	Wilson Tool Mfg. Co. Cat. No. 600S
1 each	Steel storage unit for jig, die and tools	Equipto Co. 1164 and 1198

2. General Workshop

The ship fitters and welding shop, now referred to as the general workshop, is to be used primarily for structural work, cutting and welding. Historically, Hudson Laboratories had provided their own ship fitting personnel to provide tie-downs, stowage facilities and temporary structures. The equipment contained in this general workshop is as follows:

GENERAL WORKSHOP

Quantity	Description	Drawing, NAVSHIPS No. and Commercial Equivalent or Equal
1	Waste can, oily, galvanized steel, hinged cover, Type I, Size C	RR-C-114
1	Metal stock rack, 12 ft long x 3 ft wide x 8 ft high	
1	Welding slab, Type B	5000-S9102-841140

GENERAL WORKSHOP (Continued)

Quantity	Description	Drawing, NAVSHIPS No. and Commercial Equivalent or Equal
1	Power hacksaw, 6 in. x 6 in. Type II, Size 3	Marvel Co. Model No. 6
1	Arc welder, 300 amp portable generator set, Type B	MIL-W-80019
1	Stool, steel	Jamestown Metal Co. No. 14
1	Welding curtain, Type A, Grade A, Class 1	SS-C-466
1	Vise, 6 in., machinists	L. S. Starret Co. Model Cat. No. 326
1	Workbench, 4 ft long x 28 in. wide x 34 in. high	Equipto Co. Ser 245-4A
1	Workbench, 4 ft long x 28 in. wide x 34 in. high with bonded wood top	Equipto Co. Ser 227-4
1	Test switchboard, general purpose	815-1853036

3. Personnel Day Room, Scientific Office and Library

The personnel day room and scientific office and library, located in the port hull on this deck, contain facilities for off-duty relaxation of scientific personnel. The day room may also be used as a ready room, or conference room. The library offers an area for relaxation during off hours in a quiet atmosphere and a reference area for engineering and scientific literature. No detailed layouts of these areas are presented here, since they are only equipped with furniture.

4. Photographic Laboratory

Figure 35 illustrates the layout of the photographic laboratory located in the starboard hull on the second deck. Naval Research Laboratory

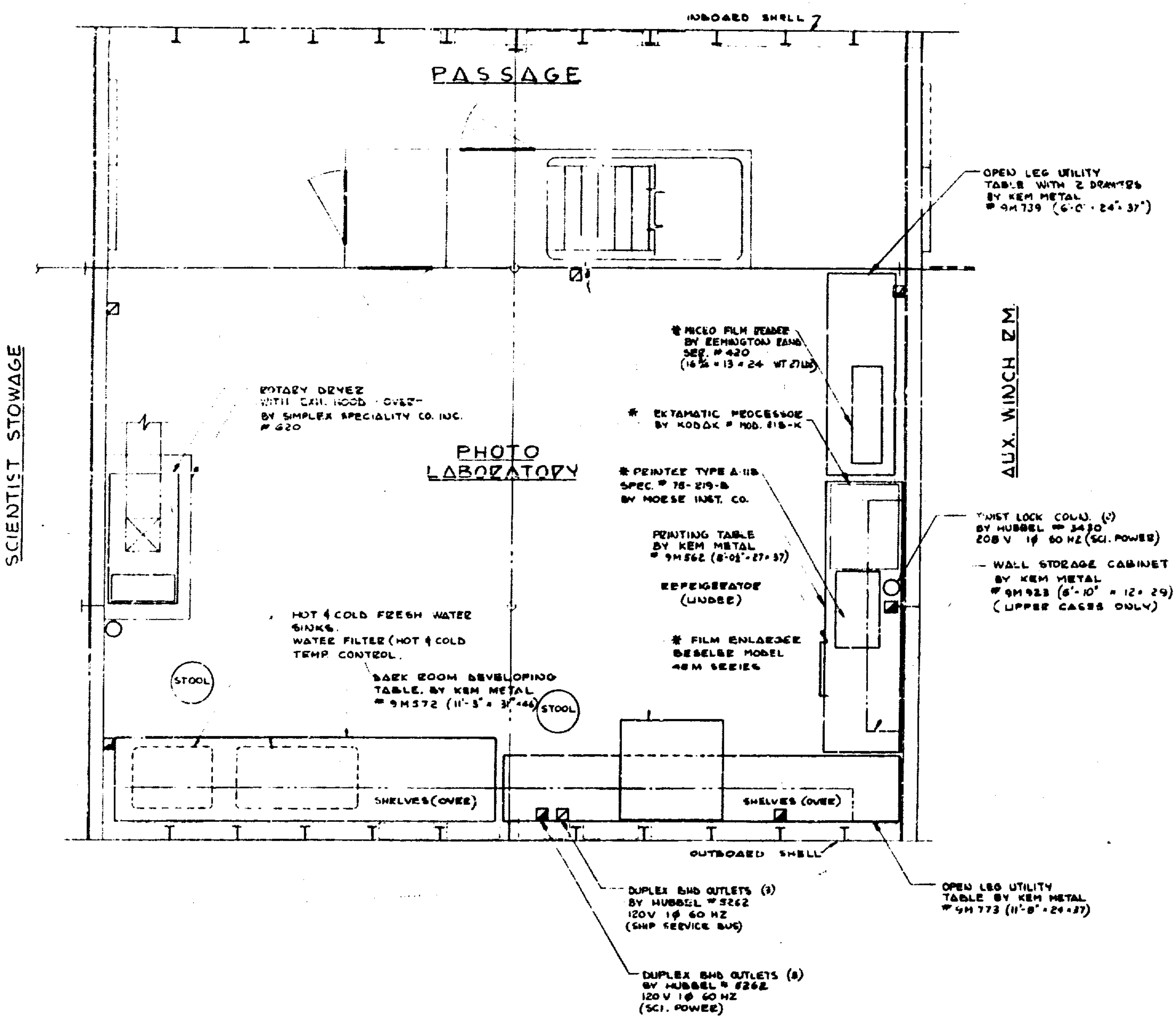


Fig. 35 - Photographic Laboratory

plans call for the conversion of this laboratory to a combined photographic, biochemical laboratory. The proposed list of equipment originally to be supplied by Hudson Laboratories was as follows:

PHOTOGRAPHIC LABORATORY

Quantity	Description	Drawing, NAVSHIPS No. and Commercial Equivalent or Equal
2	Work table, 5 ft long x 24 in. wide x 37 in. high	Kem Metal Company No. 9M736
1	Microfilm reader	Remington Rand Co. Serial No. 420
1	Processor	Kodak Ektamatic Model 218-K
1	Contact printer, Type A-11B	Morse Instrument Co. Spec. No. 75-219-B
1	Printing table, 8 ft 1-1/2 in. long x 27 in. wide x 37 in. high	Kem Metal Co. No. 9M562
1	Refrigerator - 4 cubic ft, Type I	MIL-R-19003
1	Wall storage cabinet, 35 in. long x 12 in. wide x 29 in. high	Kem Metal Co. No. 1M641
2	Shelves, 22 ft 0 in. long x 12 in. wide	
1	Film enlarger, 8 mm to 4 in. x 5 in.	Besseler Co. Model 45M Series
1	Telephone, dial	
2	Stool, with cushion	Fisher Scientific Co. No. 91-251
1	Dark room developing table, 11 ft 3 in. long x 31 in. wide x 46 in. high	Kem Metal Co. No. 9M572

PHOTOGRAPHIC LABORATORY (Continued)

Quantity	Description	Drawing. NAVSHIPS No. and Commercial Equivalent or Equal
1	Sink, photographic, hot and cold faucets, filter and hookup connections, temperature control	
1	Sink, hot and cold faucets, fresh water and cold sea water	
1	Dryer, rotary	Simplex Specialty Co. Model No. 620
1	Table, adjustable, 36 in. x 36 in.	Besseler Adjusta-Table No. 8975
1	Wall storage Cabinet, 47 in. long x 12 in. wide x 29 in. high	Kem Metal Co. No. 1M642

B. Main Deck

The working areas of major interest to the scientific and engineering community forward of frame 72 are limited to overboarding facilities and equipment, and will be discussed in a later section. Provision has been made for stowage of bottom cores on the exterior bulkhead at frame 72 on the port side.

1. Main Electronics Laboratory

The arrangement of the extremely commodious main deck electronics laboratory is shown in Fig. 36. Ready access is provided from this laboratory to the center well area forward and to the athwartship passageway aft of the laboratory which leads to other scientific areas. The amplifier room, which is really an adjunct of the electronics laboratory, is accessible through an arch and a door separates the electronics laboratory from the wet laboratory located over the starboard hull.

As described in the general arrangement section, equipment can be installed in the electronics laboratory through the overhead hatch shown in the figure by

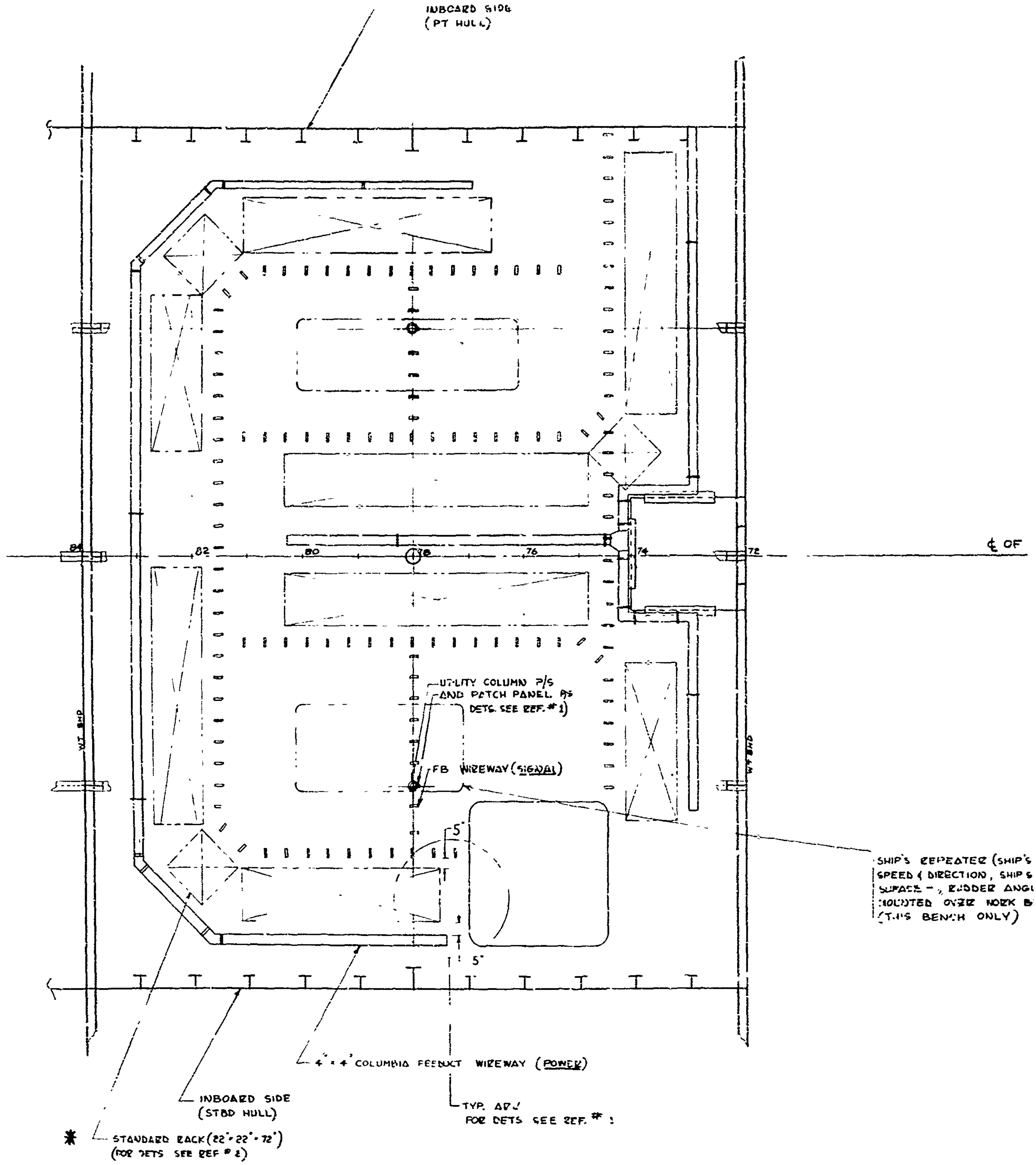
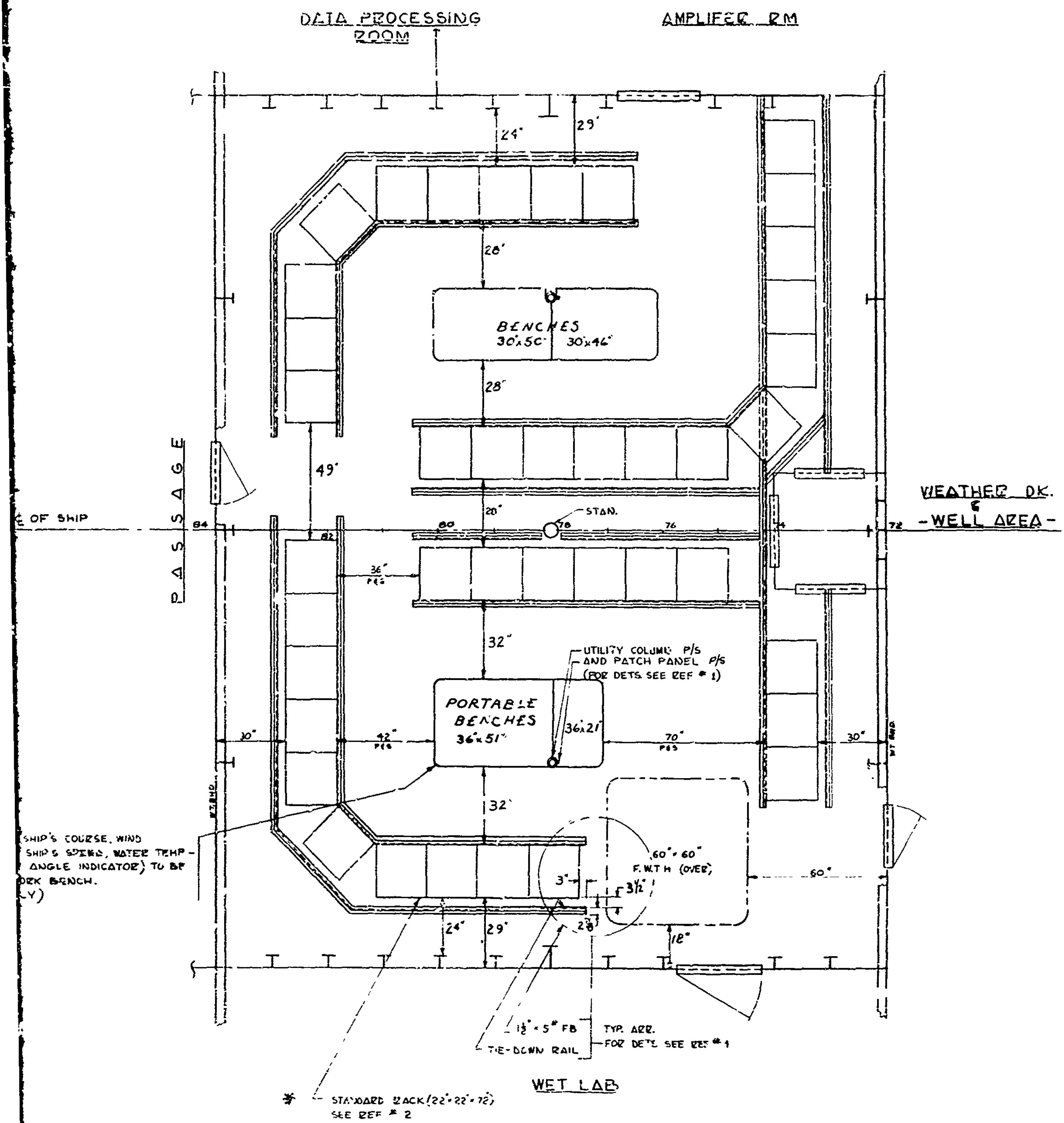


Fig. 36 - Electronics Laboratory
Main Deck - Frames 72-84



DATA PROCESSING ROOM
AMPLIFER RM
24"
29"
28"
BENCHES
30"x50"
30"x46"
28"
49"
PASSAGE
WEATHER DK.
-WELL AREA-
℄ OF SHIP
84
82
80
78
76
72
STAN.
20"
36" REQ
32"
UTILITY COLUMN P/S AND PATCH PANEL P/S (FOR DETS SEE REF # 1)
PORTABLE BENCHES
36"x51"
36"x21"
30"
42" REQ
70" REQ
30"
32"
SHIP'S COURSE, WIND
SHIP'S SPEED, WATER TEMP -
ANGLE INDICATOR) TO BE
ORK BENCH.
Y)
60"x60"
F.W.T.H (OVER)
60"
3"
3½"
2⅝"
18"
24"
29"
1½" x 5" FB
TIE-DOWN RAIL
TYP. ARR.
FOR DETS SEE REF # 1
WET LAB
STANDARD RACK (22"x22"x72")
SEE REF # 2

D

using the midships crane and/or handling gear located in the main recording laboratory on the 01 level. Provision has been made for mounting forty 22 in. x 22 in. x 5 ft high racks in the electronics laboratory. The types of operations carried out by Hudson Laboratories in the past required an almost complete interchange of equipment at each port call. When three-month cruises were required, equipment aboard the GIBBS and other ships used by the Laboratories had to be removed from the laboratory spaces and interchanged with other equipment in the storage holds. It appeared that the size of the catamaran laboratories would preclude the need for storing racks in holds. It is possible to mount and test out electronic systems in a laboratory of this size before the ship leaves port, and to have it ready for use several months later at a remote location. A multitude of experiments, large and small, can be set up in advance with this arrangement. Although the figure indicates only racks in the spaces, we planned on providing a series of modular components, such as desks, file cabinets, parts cabinets, work tables specialized recording equipment which is considerably larger than the standard racks, etc. An area in the basement of the facilities at Dobbs Ferry was to be set aside for the physcial layout of these modules and interconnection of wiring between racks on a test basis prior to loading of the ship. Complete flexibility was to be the keynote. The method of holding the racks and modular equipment in place is shown in a later figure in the section describing the main recording laboratory.

Various repeaters were to be installed in a panel mounted on a stanchion adjacent to one of the portable workbenches providing a "command area". Power ducts are scheduled to be mounted in the overhead to feed the rack spaces from behind. Open wireways are provided in front of the proposed rack areas for t. - temporary installation of signal cables specific to each experiment. These wires can be led to a patch panel for distribution elsewhere on the ship.

2. Electronic Shop (Power Amplifier Room)

Figure 37 is a layout of one of the electronic shops, which is actually a power amplifier room. The electronic shop contains two 10 KW power amplifiers permanently installed and one semi-portable 5 KW unit intended originally for installation aboard the USS ALLEGHENY. The 10 KW units can be operated in parallel and a power distribution junction box is provided which is the origin of a power distribution network connecting to all of the winch areas and overboarding areas of the ship. Utilizing this network one can power acoustic sound sources lowered from any part of the ship through power slip rings which have been mounted on most winch drums.

3. Data Processing Laboratory

Figure 37 also shows a data processing laboratory which has considerable counter space and was to be used for examination of pen recorder records, etc.

4. Wet Laboratory

The wet laboratory is illustrated in Fig. 38. Hudson Laboratories scientists planned on using this area for analysis of water samples obtained by Nansen bottle casts, bottom core analysis, spectroscopy, general chemical analysis work, nuclear trace work, etc. This laboratory is located adjacent to the midship auxiliary winch area and is, therefore, convenient to the source of water samples. A pass-through door is provided from the weather deck to a rotary stowage table located just within the laboratory. Two rows of Nansen bottle stowage racks are provided adjacent to a deep sink. Space is provided for mounting of four electronic racks or other equipment, such as an anatomic mass spectrometer. Fume hoods are provided for removal of gas fumes generated in the spectroscopy work. A total of eight bottles of oxygen,

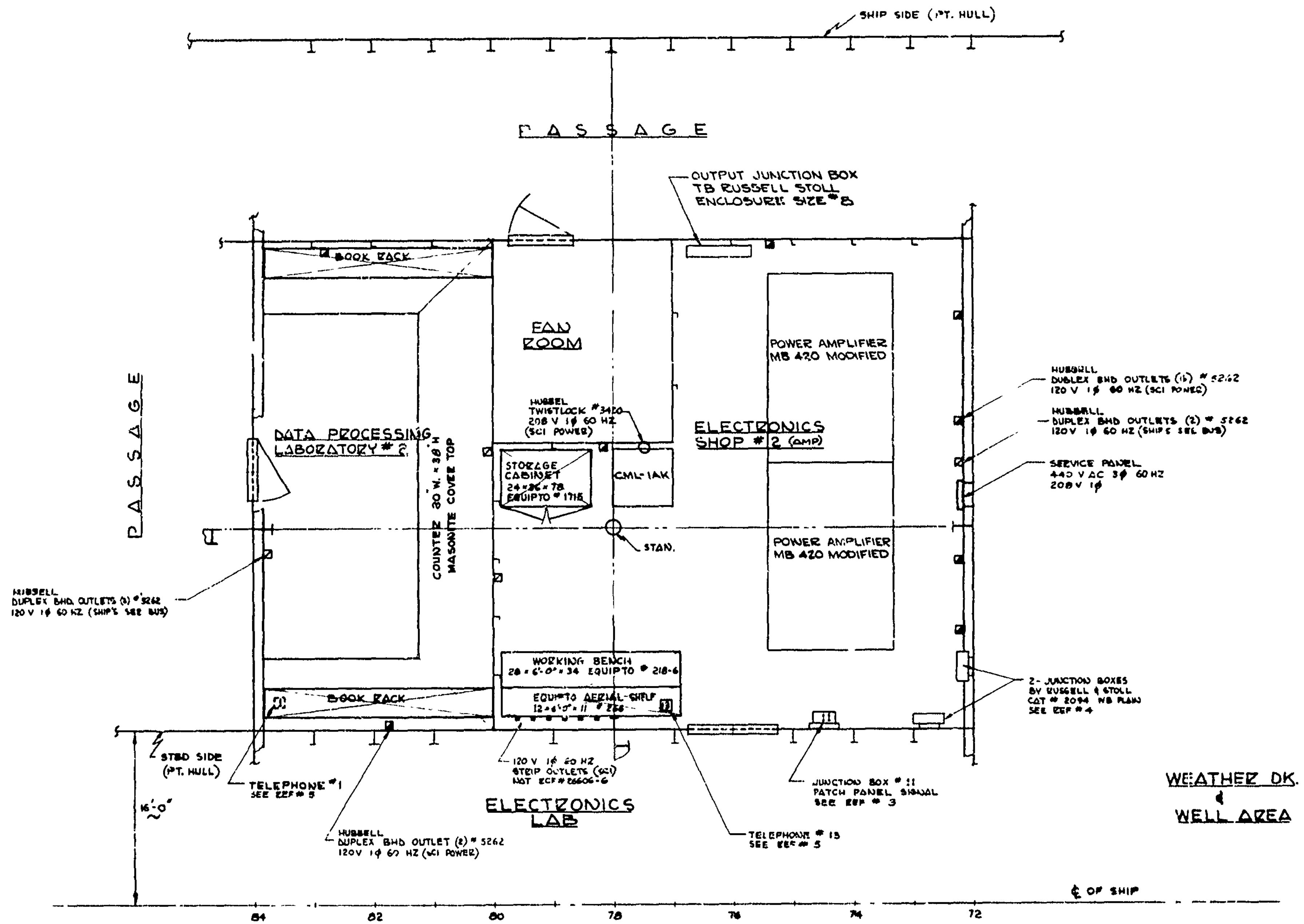


Fig. 37 - Electronics Shop (Power Amplifier Room) and Data Processing Laboratory - Main Deck

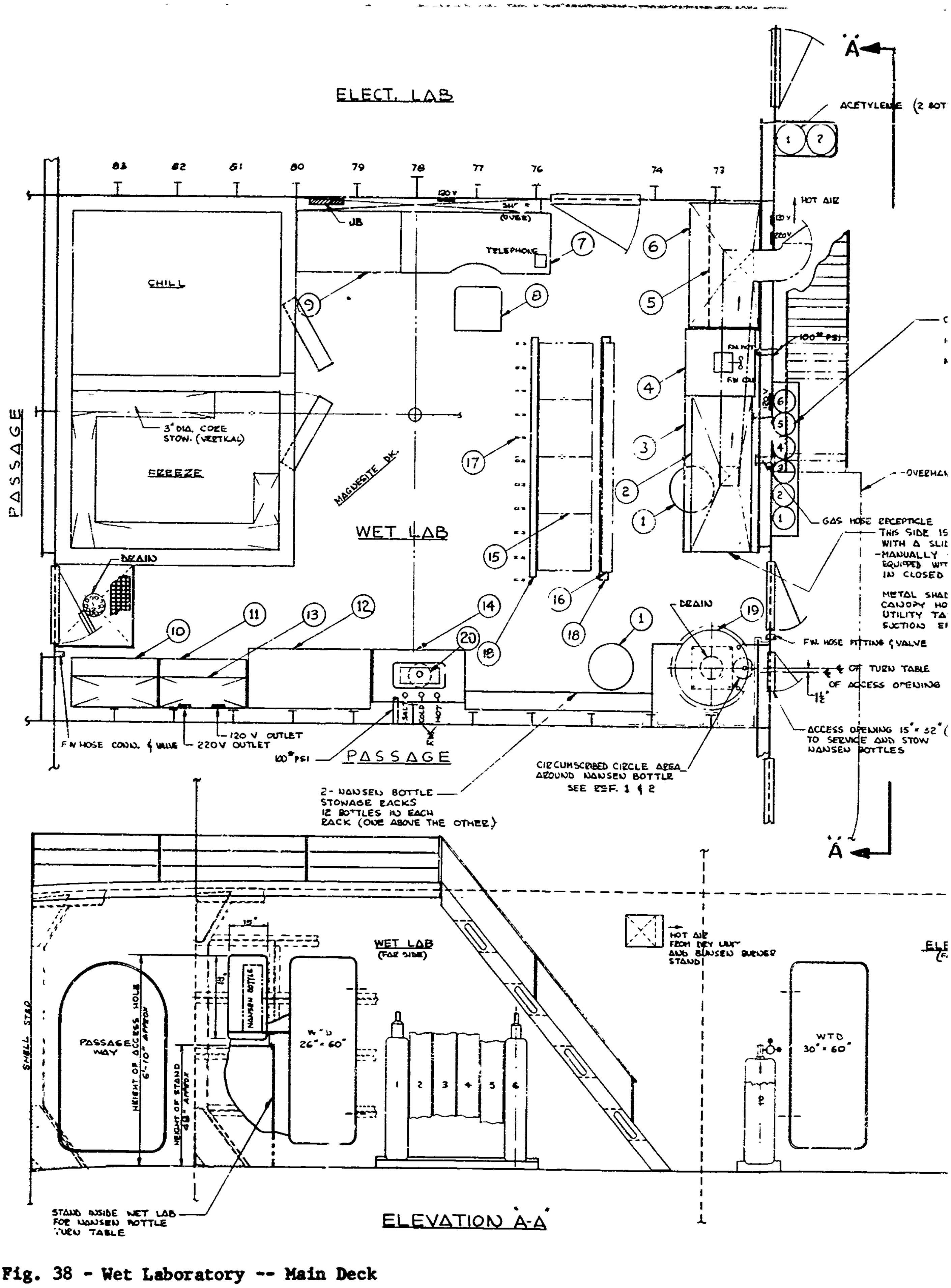
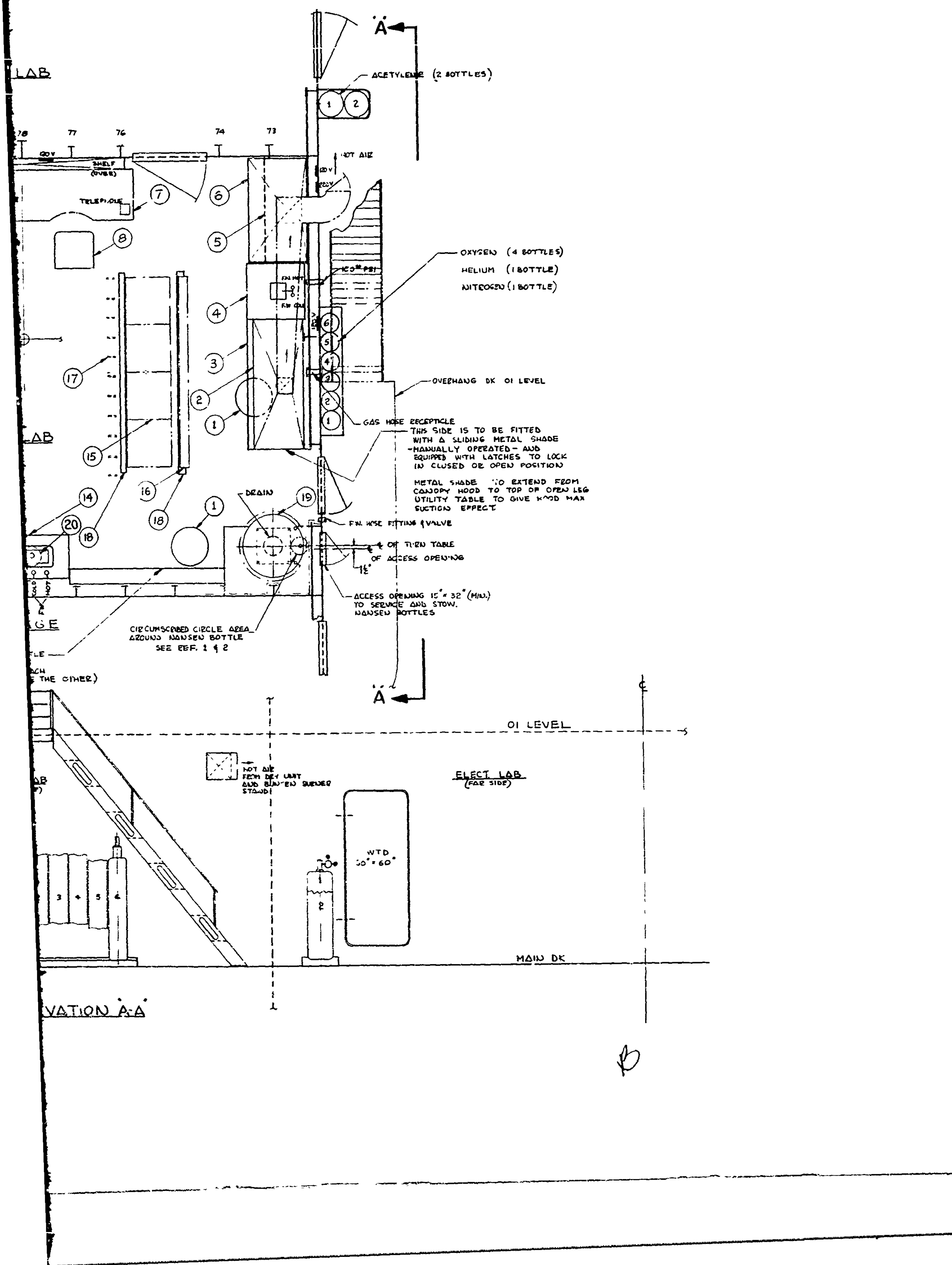


Fig. 38 - Wet Laboratory -- Main Deck



"A"
LAB
ACETYLENE (2 BOTTLES)
78 77 76 74 73
120V
SHELF (OVER)
HOT AIR
TELEPHONE
OXYGEN (4 BOTTLES)
HELIUM (1 BOTTLE)
NITROGEN (1 BOTTLE)
OVERHANG DK 01 LEVEL
GAS HOSE RECEPTICLE
THIS SIDE IS TO BE FITTED WITH A SLIDING METAL SHADE -MANUALLY OPERATED- AND EQUIPPED WITH LATCHES TO LOCK IN CLOSED OR OPEN POSITION
METAL SHADE TO EXTEND FROM CANOPY HOOD TO TOP OF OPEN LEG UTILITY TABLE TO GIVE HOOD MAX SUCTION EFFECT
LAB
DRAIN
F.W. HOSE FITTING & VALVE
℄ OF TURN TABLE OF ACCESS OPENING
ACCESS OPENING 15" x 32" (MIN.) TO SERVICE AND STOW. NANSEN BOTTLES
COLD HOT
AGE
CIRCUMSCRIBED CIRCLE AREA AROUND NANSEN BOTTLE SEE REF. 1 & 2
THE OTHER)
"A"
01 LEVEL
HOT AIR FROM DRY UNIT AND BUNSEN BURNER STAND
ELECT. LAB (FAR SIDE)
WTD 30" x 60"
MAIN DK
VATION "A-A"

helium and nitrogen, all used with the spectroscopy equipment, can be mounted outside the forward bulkhead of this compartment. A microscope table is provided and large chill and freeze compartments provide considerable space for storing frozen water samples and short core sections. The chill compartment is convertible to freeze and vice-versa. The deck of this compartment is masonite and it is tapered to a pair of drains, one under the Nansen rack and one under the chemical shower head.

The layout of this compartment and the equipment list which follows in the text is indicative of the detailed effort exerted by the engineering personnel at Hudson Laboratories in the definition of the ship and equipment specifications.

EQUIPMENT LIST - WET LABORATORY

Number Required	Description	Drawing and Catalog Numbers	Remarks
2	Stool		
1	Canopy Hood, 60 x 18 x 24	Cat. No. 2B2818-5	Kem Metal
1	Open Leg Utility Table	Cat. No. 9M717	Kem Metal
1	Wall Sink	Cat. No. 1D602	Kem Metal
1	Electric Dryer Unit	Cat. No. 1M446	Kem Metal
1	Fume Hood - Closed Front	Cat. No. 2B24K	Kem Metal
1	Microscope Table	Cat. No. 9M850	Kem Metal
1	Desk Chair		
1	Counter - Cabinet Under	Cat. No. 9M710	Kem Metal
1	Base Cabinet - Drawer Unit	Cat. No. 1M219	Kem Metal

EQUIPMENT LIST - WET LABORATORY (Continued)

Number Required	Description	Drawing and Catalog Numbers	Remarks
1	Base Cabinet - Drawer Unit	Cat. No. 1M225	Kem Metal
1	Titration Wall Table	Cat. No. 9M1011	Kem Metal
2	Sliding Door Wall Storage Case	Cat. No. 1M641	Kem Metal
1	Deep Slop Sink		
4	Standard Electric Rack	Rem-O-Rack No. 114A	Premier Metal Products
-	Feeduct Wire-Way (Power)	Cat-S-2-10 (E)	Hudson Laboratories
-	Flat Bar Wire-Way (Signal)	Cat-S-2-10 (E)	Hudson Laboratories
-	Tie-Down Foundations	Cat-S-2-10 (E)	Hudson Laboratories
1	Nansen Bottle Stowage (Turn Table)	630-S-001	Hudson Laboratories
2	Sediment Trap	Cat. No. 910A (2 gal.)	Nalge Company

5. Mechanical Engineering Shop

The mechanical engineering shop shown on Fig. 39 is centrally located aft with access through a passageway to other compartments forward and to the open deck aft. This area is intended as an assembly, test, and repair area for a variety of equipment. Double access doors on the after bulkhead to starboard and a monorail serving these doors are provided to bring large acoustic sound sources and other equipment into the shop area. Ovens, vacuum, mixing and ventilation equipment are provided primarily for repairs to potted and molded assemblies and components, particularly hydrophone arrays. Slop sinks, bench tools, welding equipment and deck and bulkhead hold downs are provided.

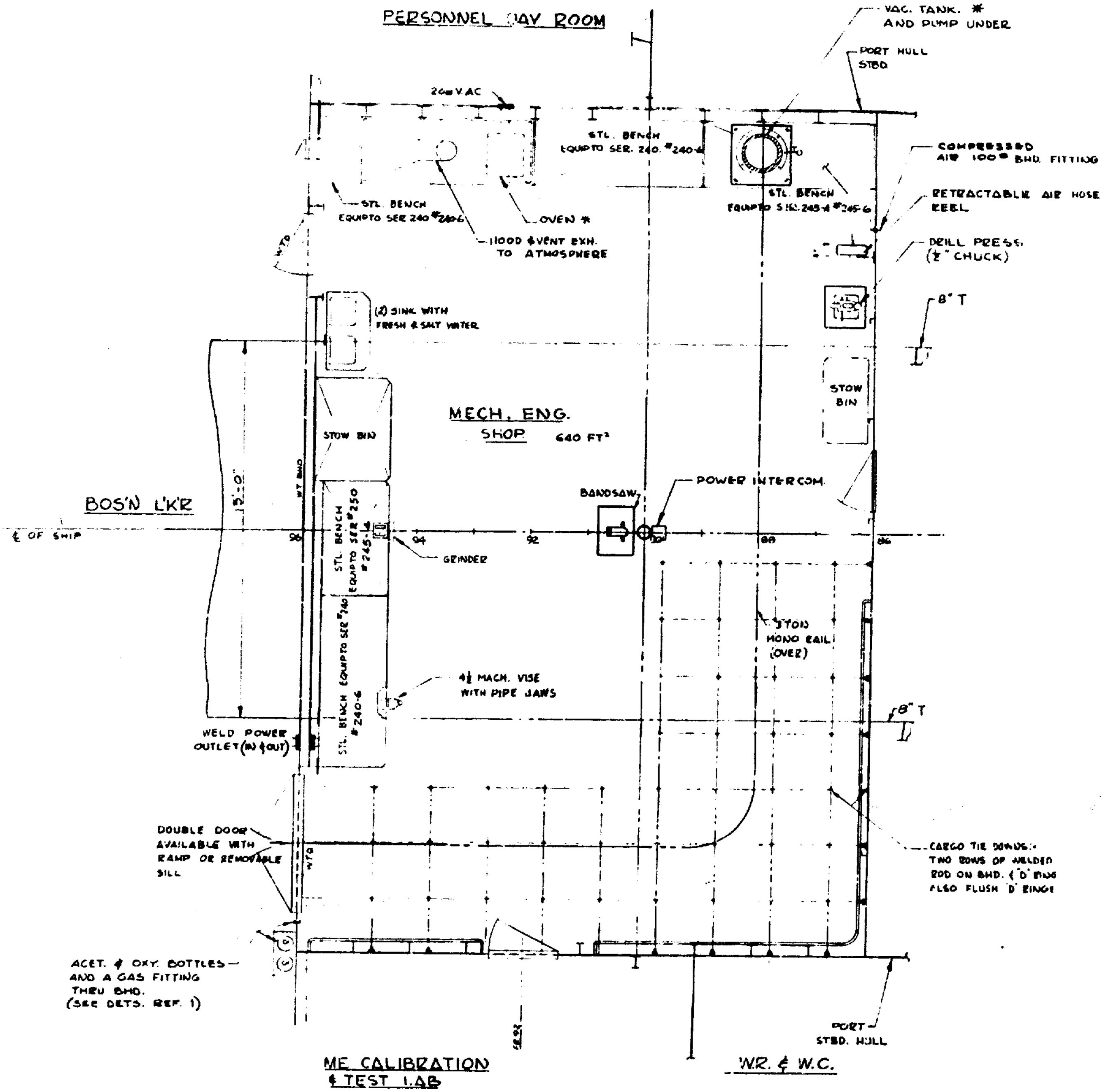


Fig. 39 - Mechanical Engineering Shop -- Main Deck

6. Mechanical Engineering Calibration and Test Laboratory

The mechanical engineering calibration and test laboratory shown on Fig. 40 is adjacent to the aforementioned shop. It was planned to provide this laboratory with bathythermograph calibration and repair facilities, halide leak detection equipment, pressure gauge calibration equipment, and hydrophone test and calibration equipment. A 16 in. shell converted to a 6000 psi pressure test chamber was to be installed with the nose of the projectile penetrating the deck within a watertight cylindrical enclosure. This shell was to be provided by Hudson Laboratories and was to be equipped with electrical feed through connectors for pressure test and evaluation of electronic gear and hydrophones.

7. Personnel Day Room

Reference to Fig. 27 shows a personnel day room located over the port hull with access to the main deck aft. This room was to be equipped with a refrigerator, coffeemaker, toaster, scuttlebutt, etc. A similar compartment on the USNS GIBBS saw extended service. It provides an area in which the technicians who generally work on the open deck can take refuge during bad weather or can relax during short breaks in the work schedule. Our experience indicated that having a room of this nature close to the work area keeps the technicians in one location and readily available when they are required. The area is also very popular with other personnel who work within the laboratory areas when they take a coffee break.

8. Scientific Boatswain's Locker

Figure 27 shows the location of the scientific boatswain locker at the base of the after crane. Since Hudson Laboratories personnel performed

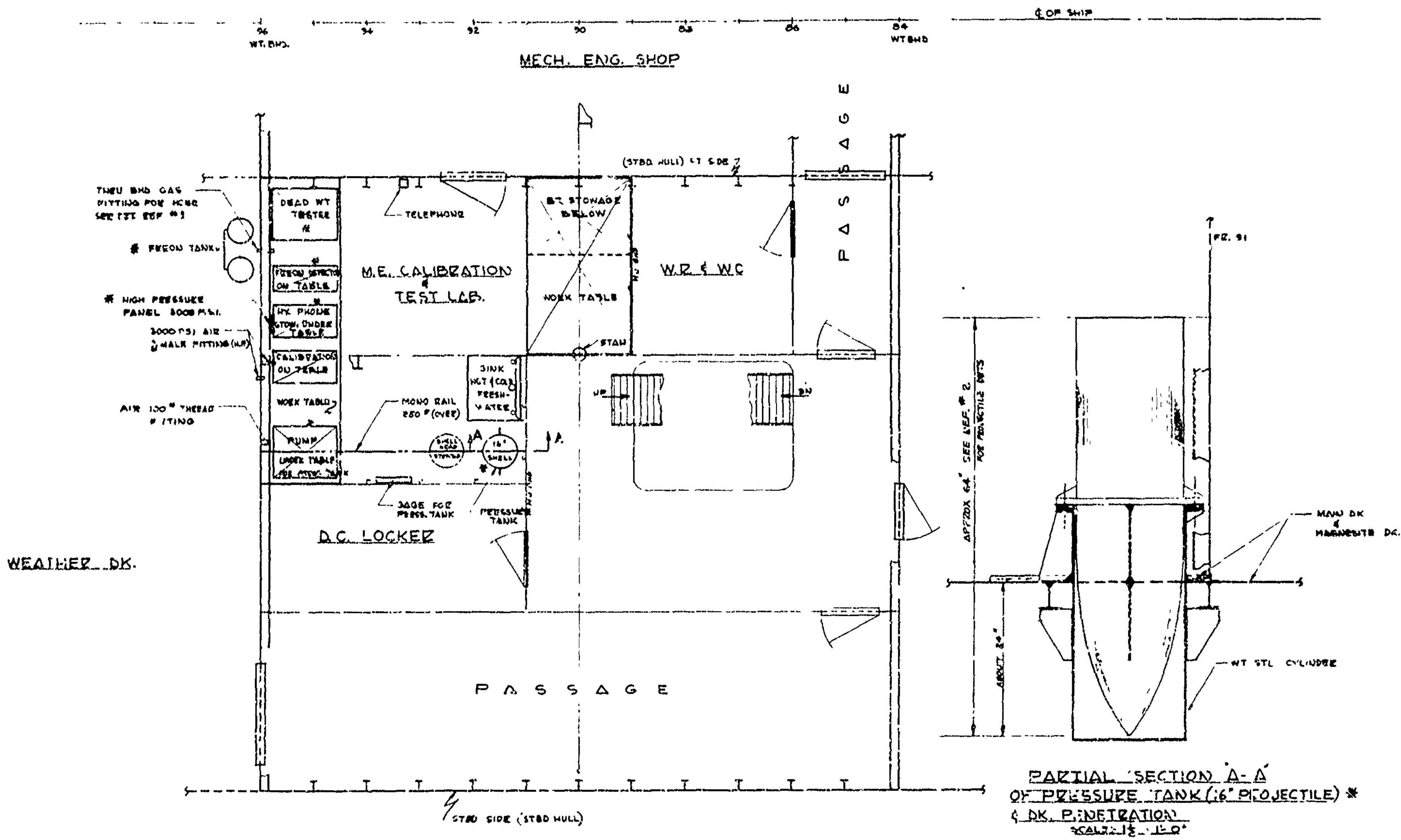


Fig. 40 - Mechanical Engineering Calibration and Test Laboratory

1. Main Recording Laboratory

The main recording laboratory is situated directly above the electronics laboratory and is identical to it in size. Figure 41 illustrates the layout of this compartment which is capable of holding 44 standard electronic racks. It should be noted that either open or closed standard racks, as well as out-sized equipment, can be utilized with this layout. The capacity of the laboratory could have been considerably enhanced if all racks were provided with pull-out draws for servicing. Instead, the layout was based on the need for access to the rear of each rack. A small davit is located along the starboard bulkhead for lowering of equipment to the electronics laboratory below. A similar hatch in the overhead is serviced by the midship rotating crane. All comments relating to power and signal distribution and repeaters covered in the discussion of the electronics laboratory are pertinent to this laboratory.

Figures 42 and 43 illustrate the method developed at Hudson to provide rack tie downs. Keyhole shaped holes are punched through the corner structures of a rack. A special fitting is inserted into the large end of this keyhole and pulled down so that the button on this fitting seats in the small end of the keyhole. A cylindrical fitting attached to a standard Camloc clamp engages a fork on the special fitting. The Camloc hardware is attached to an "L" shaped bracket with a lip at the bottom which engages a bulb angle welded to the deck. The Camloc fitting is adjustable and it is possible to generate large vertical loads on the rack to insure that it is held in position. This method has been used for a number of years aboard the USNS GIBBS and has been found to be vastly superior to methods utilizing bolts and tapped holes and is considerably more flexible than methods using channels and trapped nuts. Figure 44 is a cross sectional view of the main recording laboratory.

such evolutions as deep anchoring and did all the launching of the scientific gear, a considerable quantity of boatswain supplies were required. A scuba gear locker and 3000 psi air accumulator are provided in this area. 3000 psi air is used primarily in pneumatic acoustic sources and is supplied by a compressor in an engine room.

9. Ready Service Room

A ready service room was initially proposed for the main deck over the port hull adjacent to the personnel day room. It has been mentioned in an earlier section that this room and the magazine beneath it were to be transferred to the starboard hull. The ready service room specifications required that it meet Coast Guard regulations for "on deck magazines" class nine explosives. Stowage was to be provided for 100 cubic ft. An ammunition hoist leading from the below deck magazine to the ready service room with access to the main deck aft was specified.

Aboard the USNS GIBBS, it was found to be more convenient to utilize Coast Guard approved portable vans for on deck stowage of explosives because of the ease of access when compared to below decks magazines. It was our intention to pursue this policy where necessary when using the catamaran. Cap and fuse stowage boxes were to be provided between strength members on the overheads in after passageways far enough away from the explosives stowage to meet Coast Guard regulations.

C. 01 Deck

Forward of frame 72, all working areas relating to the scientific mission of the ship are confined to overboarding equipment and its associated areas which will be discussed in a later section.

1. Main Recording Laboratory

The main recording laboratory is situated directly above the electronics laboratory and is identical to it in size. Figure 41 illustrates the layout of this compartment which is capable of holding 44 standard electronic racks. It should be noted that either open or closed standard racks, as well as out-sized equipment, can be utilized with this layout. The capacity of the laboratory could have been considerably enhanced if all racks were provided with pull-out draws for servicing. Instead, the layout was based on the need for access to the rear of each rack. A small davit is located along the starboard bulkhead for lowering of equipment to the electronics laboratory below. A similar hatch in the overhead is serviced by the midship rotating crane. All comments relating to power and signal distribution and repeaters covered in the discussion of the electronics laboratory are pertinent to this laboratory.

Figures 42 and 43 illustrate the method developed at Hudson to provide rack tie downs. Keyhole shaped holes are punched through the corner structures of a rack. A special fitting is inserted into the large end of this keyhole and pulled down so that the button on this fitting seats in the small end of the keyhole. A cylindrical fitting attached to a standard Camloc clamp engages a fork on the special fitting. The Camloc hardware is attached to an "L" shaped bracket with a lip at the bottom which engages a bulb angle welded to the deck. The Camloc fitting is adjustable and it is possible to generate large vertical loads on the rack to insure that it is held in position. This method has been used for a number of years aboard the USNS GIBBS and has been found to be vastly superior to methods utilizing bolts and tapped holes and is considerably more flexible than methods using channels and trapped nuts. Figure 44 is a cross sectional view of the main recording laboratory.

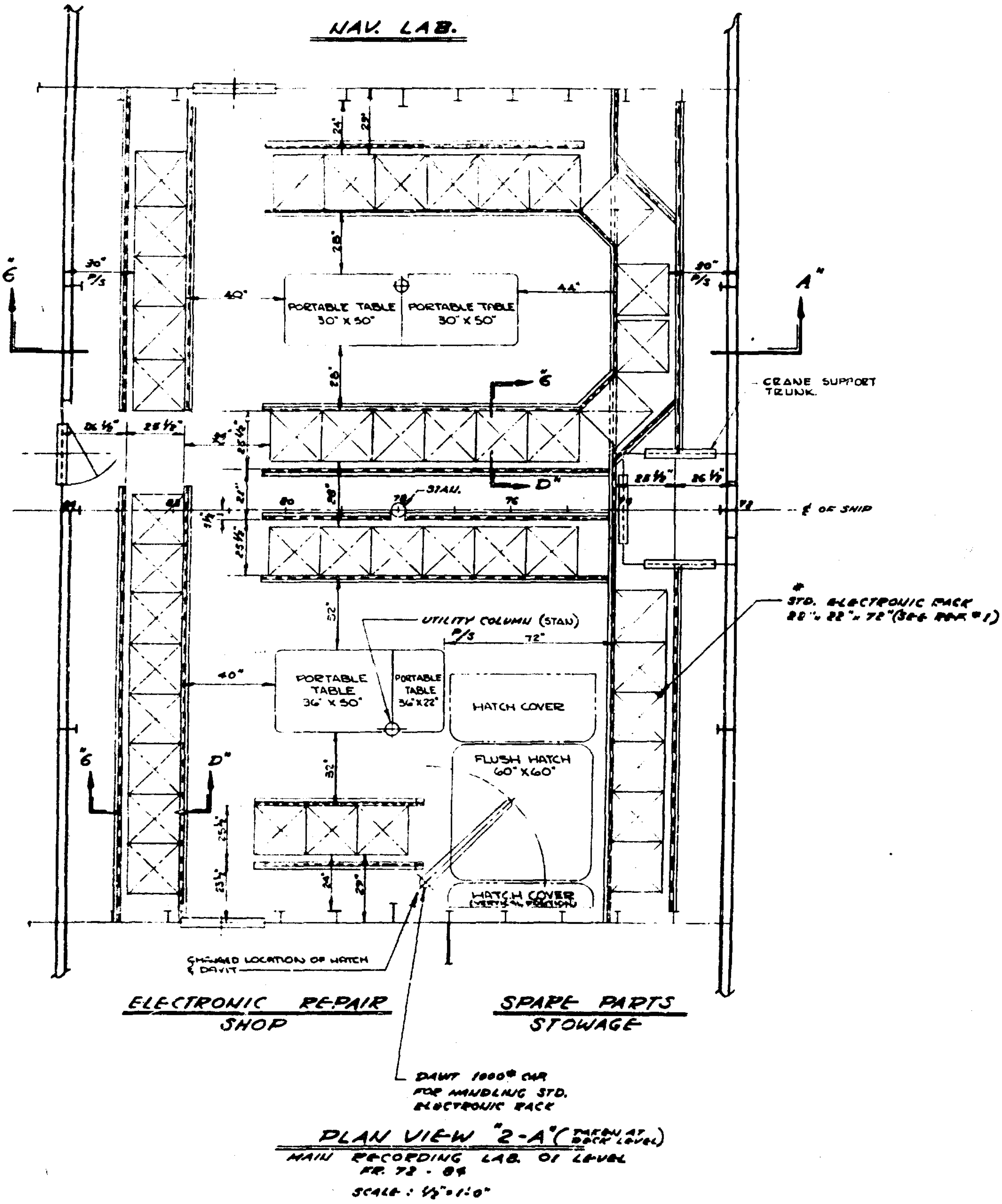


Fig. 41 - Main Recording Laboratory

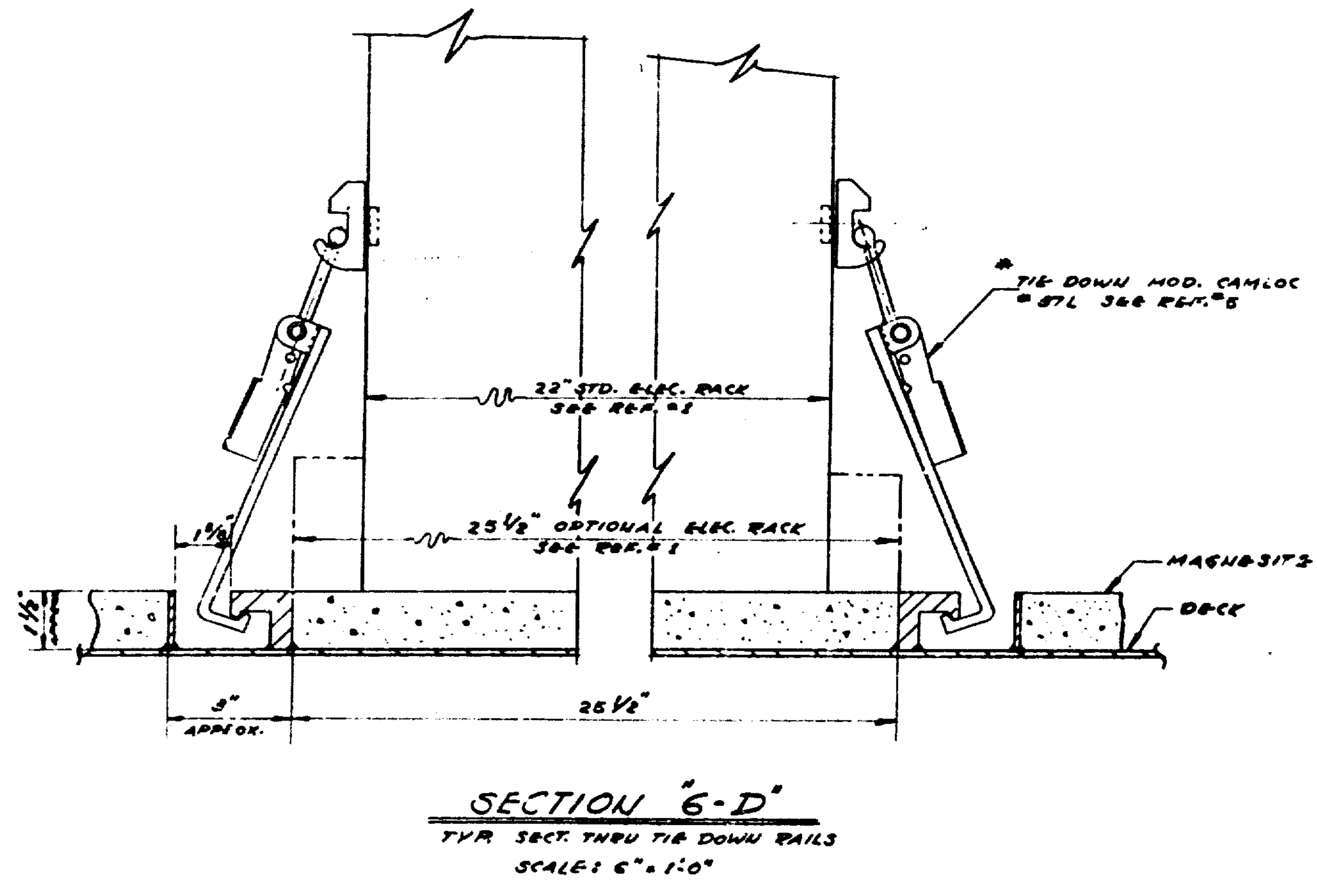
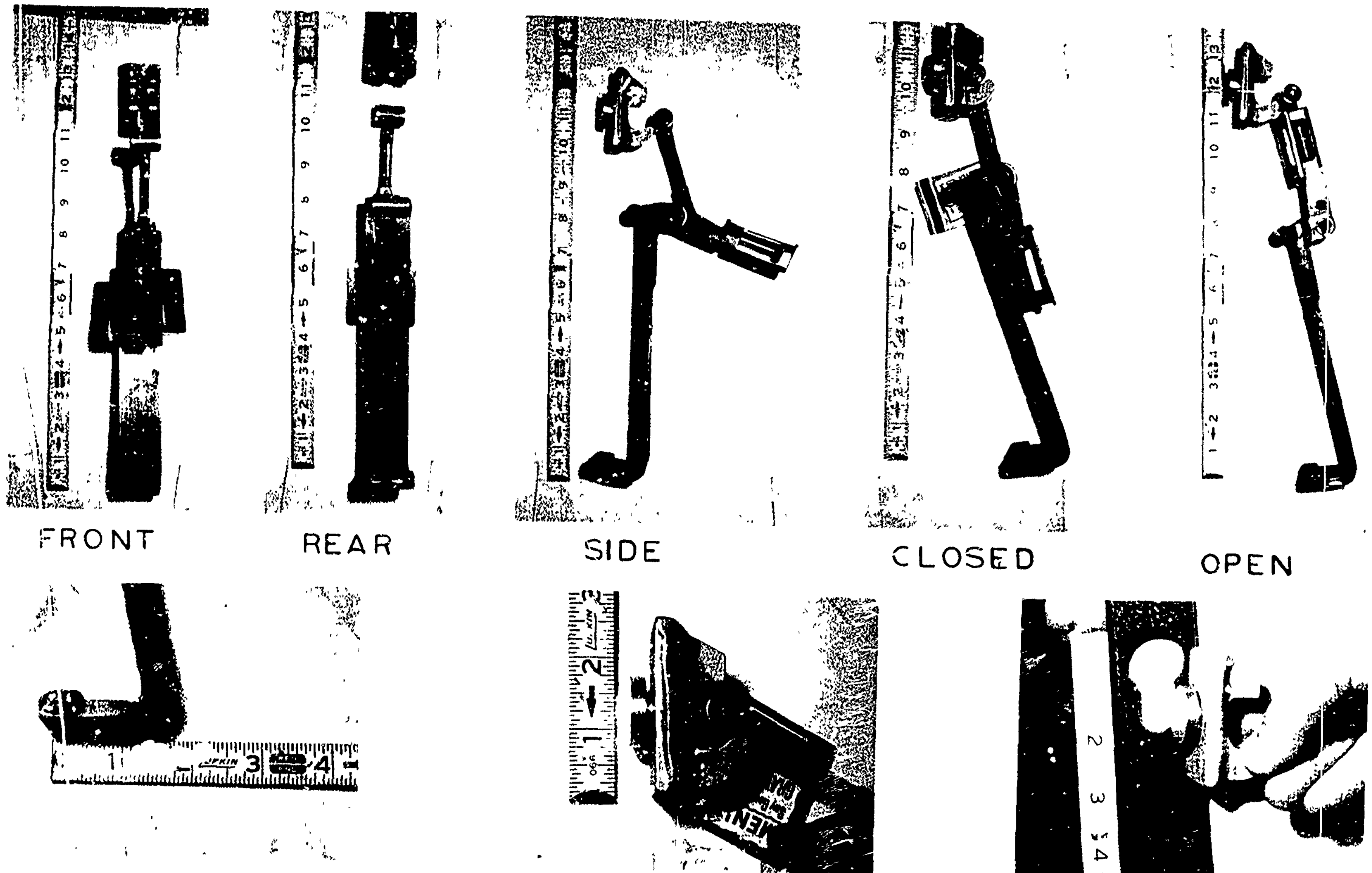


Fig. 42 - Rack Tie Down Method

RACK TIE-DOWN — CAMLOC LATCH NO. 37L MOD. BY HUDSON LAB.



FRONT REAR SIDE CLOSED OPEN

RACK CORNER

Fig. 43 - Details -- Rack Tie Downs

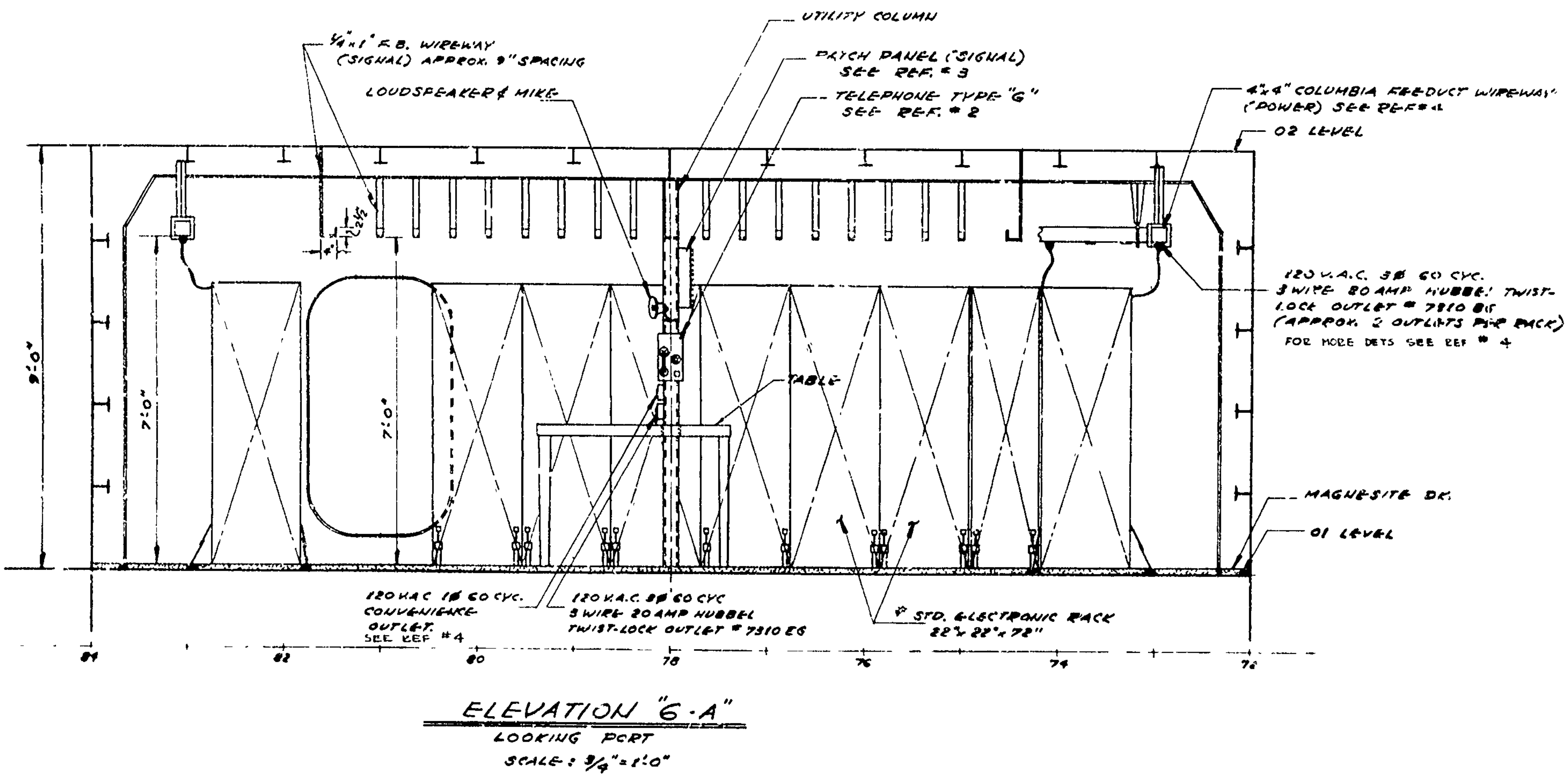


Fig. 44 - Cross Section -- Main Recording Laboratory

The main recording laboratory was to be the center of scientific activities aboard the ship. It will be located adjacent to the navigational laboratory and convenient to the scientific radio facilities and computer room.

2. Electronic Repair Shop

Figure 45 shows the layout of the electronic repair shop adjacent to the main recording laboratory. Parts stowage and repair facilities are provided. The parts stowage area can be locked during periods when the ship is undergoing overhaul. Bitter experience in the past aboard the USNS GIBBS has indicated that entire areas must be well secured or losses occur. The master patch panel for signal circuits is located in this area.

3. Research Control Center (Navigation Laboratory)

Figure 46 provides a layout of the research control center or navigation laboratory. The research control center will contain navigational equipment used by the scientific staff including Loran "C", Omega (if provided in the future), Decca and satellite navigation, complete with an associated computer. A request has been made for provision of a dead reckoning tracker to be provided as government furnished equipment. Space has been provided for the installation of an acoustic position determining or tracking system to be used in conjunction with the three instrument wells described in an earlier section. It was felt that if the USNS MISSION CAPISTRANO were to be decommissioned in the future, components of its position keeping system could be removed and put aboard the catamaran. Consideration had been given to specifying an automatic positioning and tracking system for the ship, but due to the shortage of funds, this requirement was never inserted into the specifications. Fathometer controls, readouts and recorders including those for the mechanically stabilized narrow beam

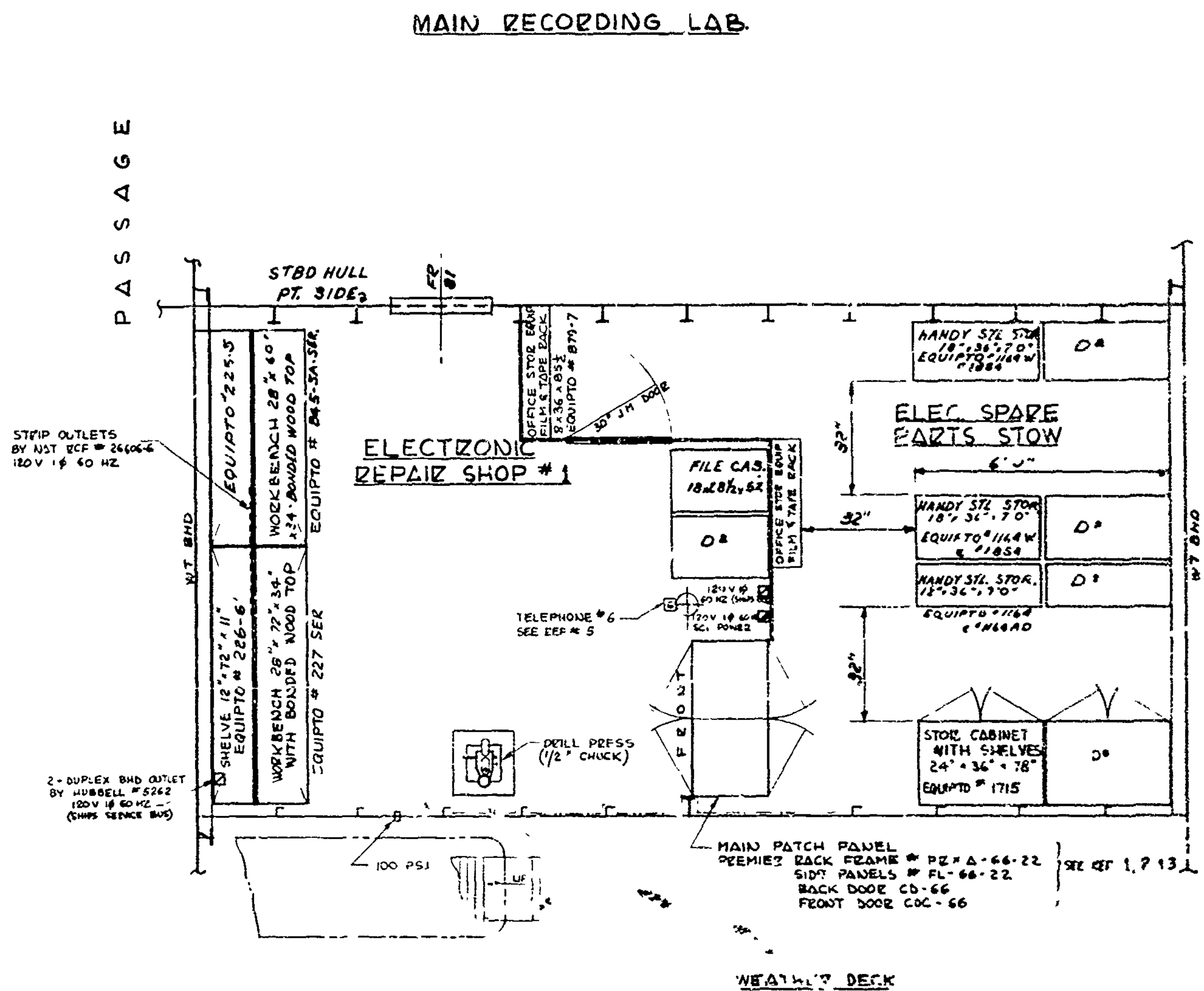


Fig. 45 - Electronic Repair Shop

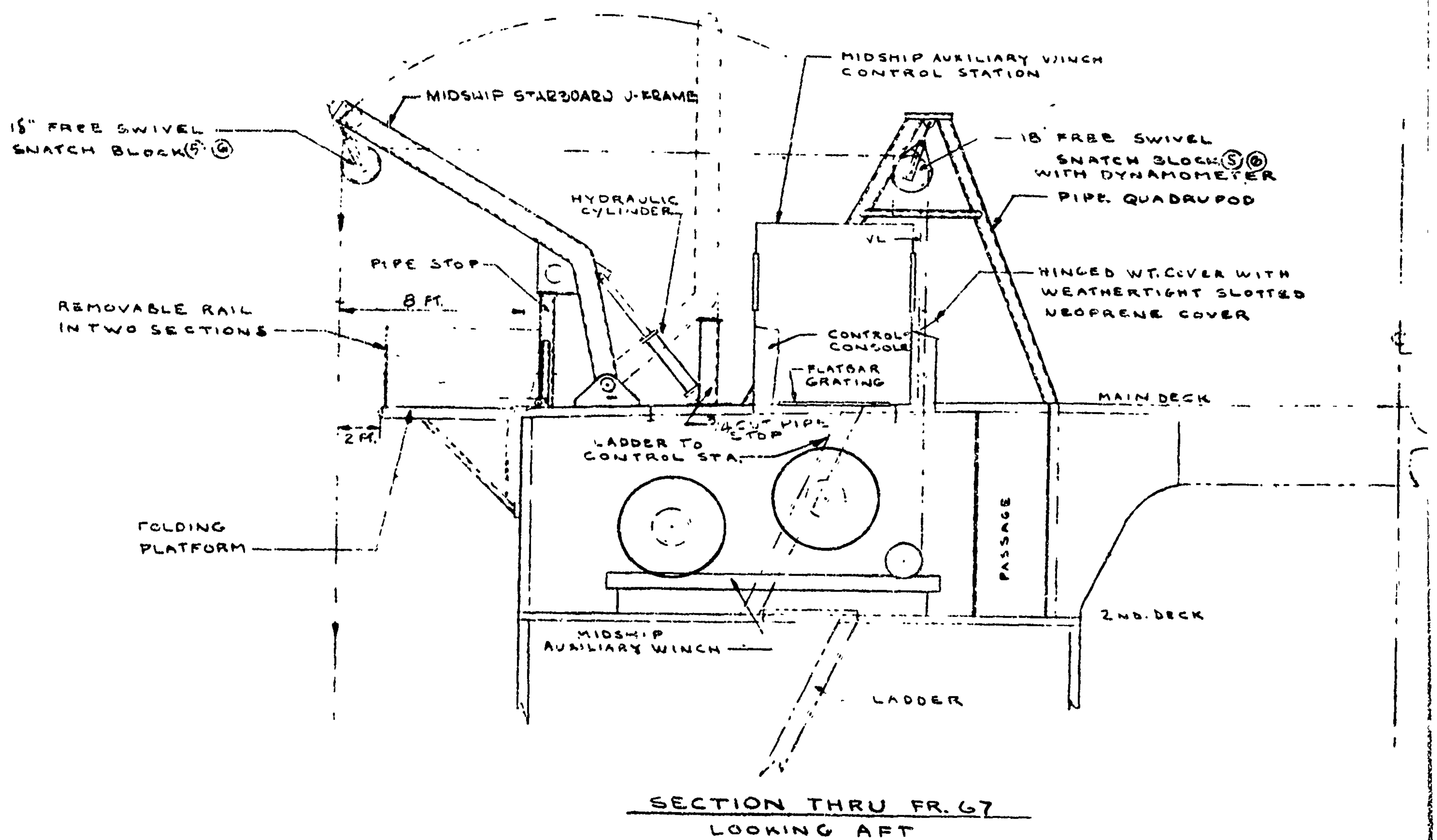


Fig. 46 - Research Control Center (Navigation Laboratory) and Scientific Radio Room

fathometer are to be installed in this compartment. Underwater telephone control and a Decca radar separate and distinct from the ship's radar system are to be provided, as well as junction boxes, power outlets and ship's repeaters.

4. Scientific Radio Room

The scientific radio room (Fig. 46) is to be equipped with the approved list of equipment described in the ship's characteristics. At first glance, it may appear that provision of a scientific radio facility represents a redundant requirement. Our operational experience has indicated that the requirements for radio communications on the part of the scientific party far exceeded the requirements for the ship's operational force. Most of the experiments carried out were acoustic experiments which required numerous field stations and ships. In addition, a radio facility existed at Hudson Laboratories and daily communications with each vessel assigned to the laboratories was required in order to monitor progress and to prepare for necessary longistic support.

5. Computer Room

Figure 47 shows the computer room which is laid out for the installation of an IBM 1800 computer. A study of the actual machine to be installed in this space was underway at the time Hudson Laboratories turned over the technical cognizance of the ship to NRL. It is probable that this IBM machine would not have been installed in this area and that a smaller machine with greater capacity would have been selected. Because of the high degree of uncertainty as to the space required, the starboard bulkhead of this compartment was specified as a portable bulkhead with a large double door in it. If more or less room is required in the computer area, this bulkhead can be moved, thereby either reducing or increasing the space available in the data processing laboratory.

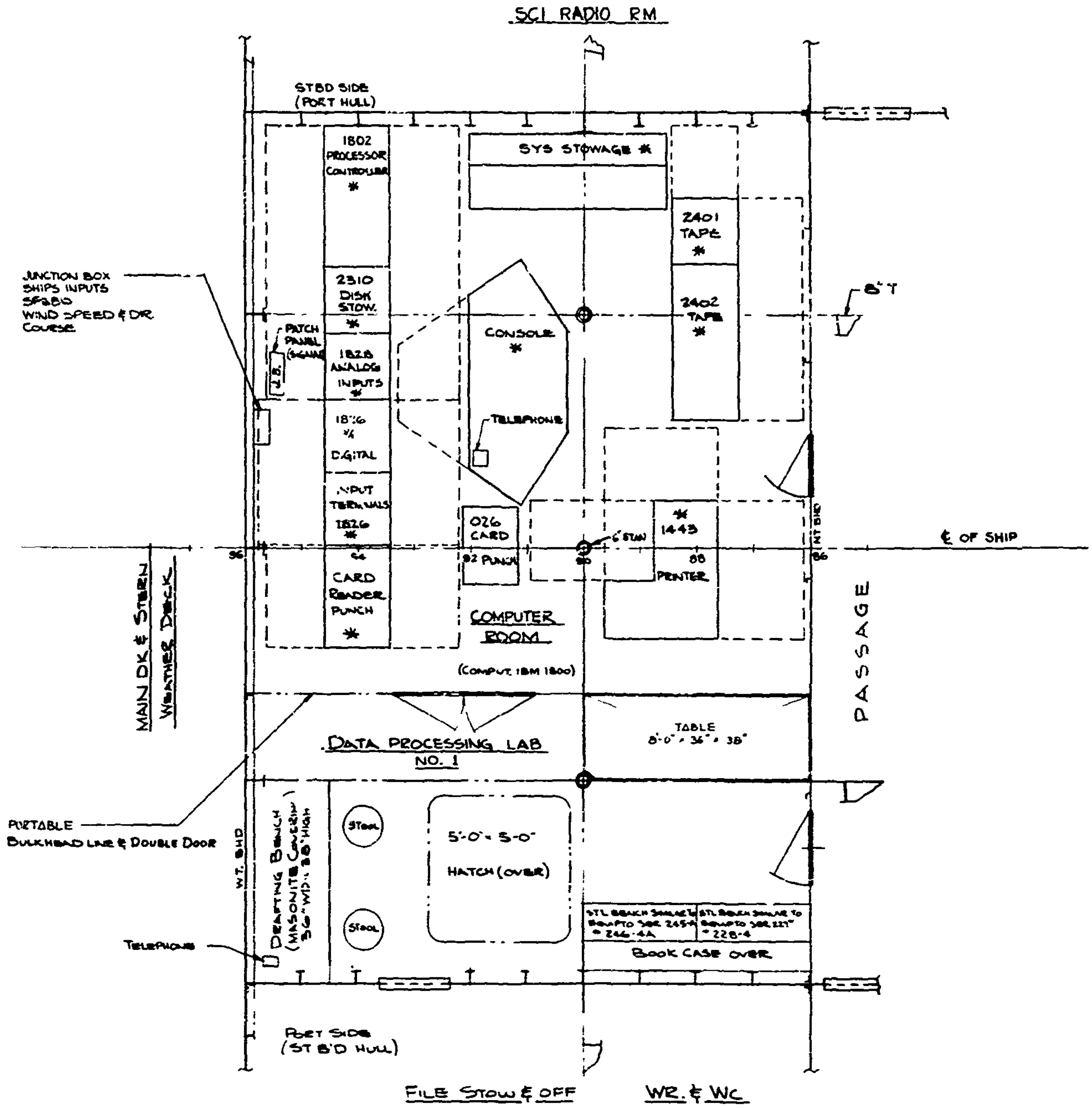


Fig. 47 - Computer Room and Data Laboratory

The scientific signal network had access to the computer room through a patch panel, allowing for on line data processing. A junction box with ship's repeater signals suitable for computer input was to be provided.

6. Data Processing Laboratory

The data processing laboratory (Fig. 47) was to be equipped with a 5-ft square hatch in its overhead for future installation or removal of computer components. The large double door allowed access from the data processing laboratory to the computer room.

IX MECHANICAL HANDLING GEAR

A. Forward Winch Complex

Figures 48 through 54 show the location of the forward traction winch and auxiliary winch, as well as the U-frames, platform, fairleads and auxiliary equipment which serve them. These two winches meet the basic specifications as described on pages D-1 and D-2 of Appendix D of this report. All of the aforementioned handling gear equipment illustrations and those showing the midship and stern areas were taken from plans drawn for the Naval Ship Engineering Center by M. Rosenblatt and Sons. Hudson Laboratories made a considerable contribution to the development of these plans.

The forward traction winch is very similar to a Western Gear Corporation winch first installed aboard the USNS GIBBS. A larger wire rope was required for anchoring the catamaran and, therefore, the specification for the maximum line pull was raised from 30,000 lb to 50,000 lb. In an attempt to keep the horsepower the same as on the GIBBS winch, the line speed at the maximum pull was reduced from 133 ft/min. to 80 ft/min. The prospective winch supplier recommended a 200 horsepower unit and the line speed was increased to 100 ft/min. It was proposed to use this winch primarily for deep anchoring during acoustic experiments. Figures 48 and 50 show the traction unit, power unit and double drum stowage unit mounted under cover on the main deck forward. The single drum stowage unit associated with this winch is located on the second deck and is shown in Figs. 50 and 54. This single drum unit was intended as a stowage drum for emergency use and for storing damaged sections of rope.

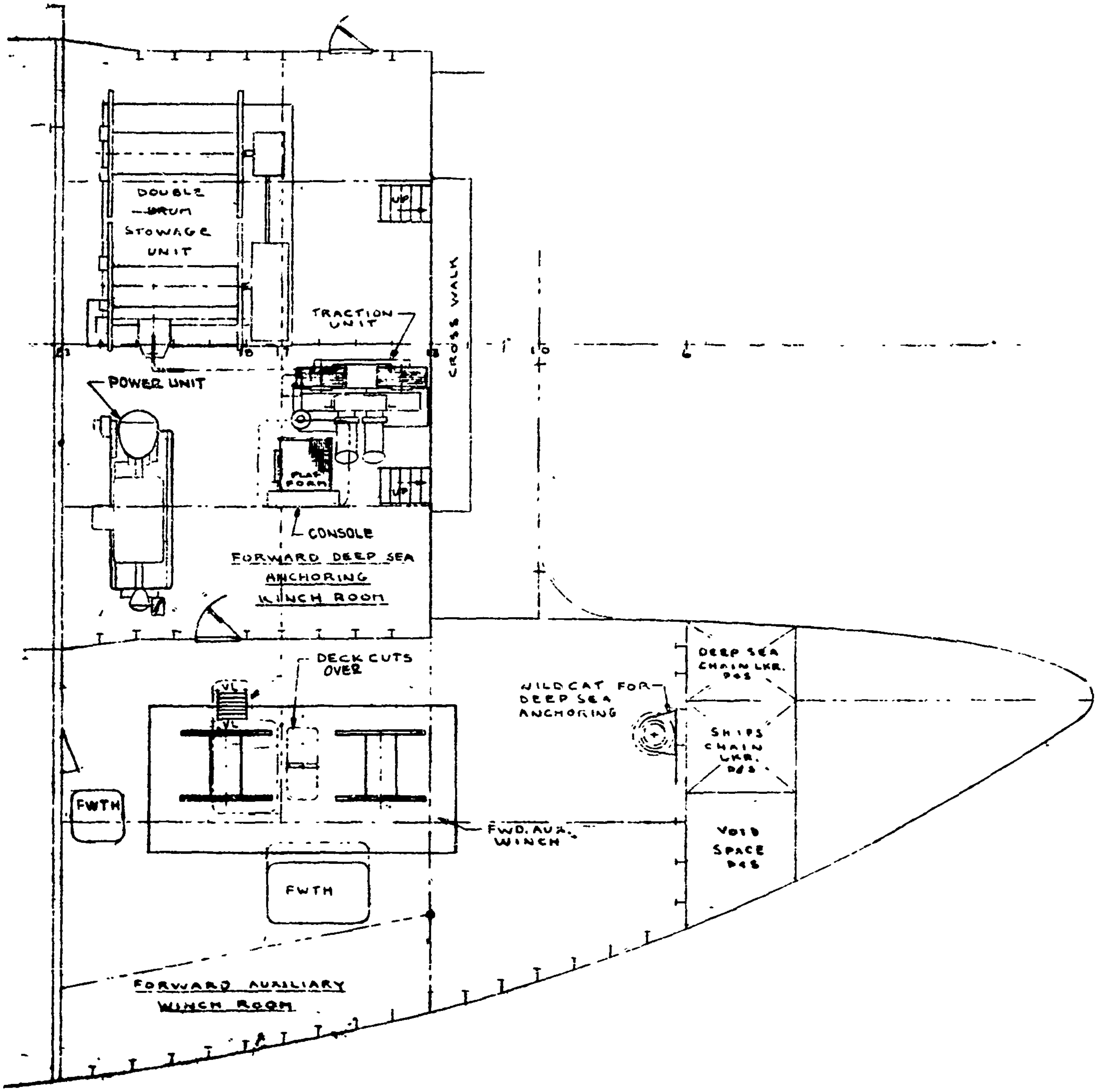


Fig. 48 - Forward Winch Complex -- Main Deck

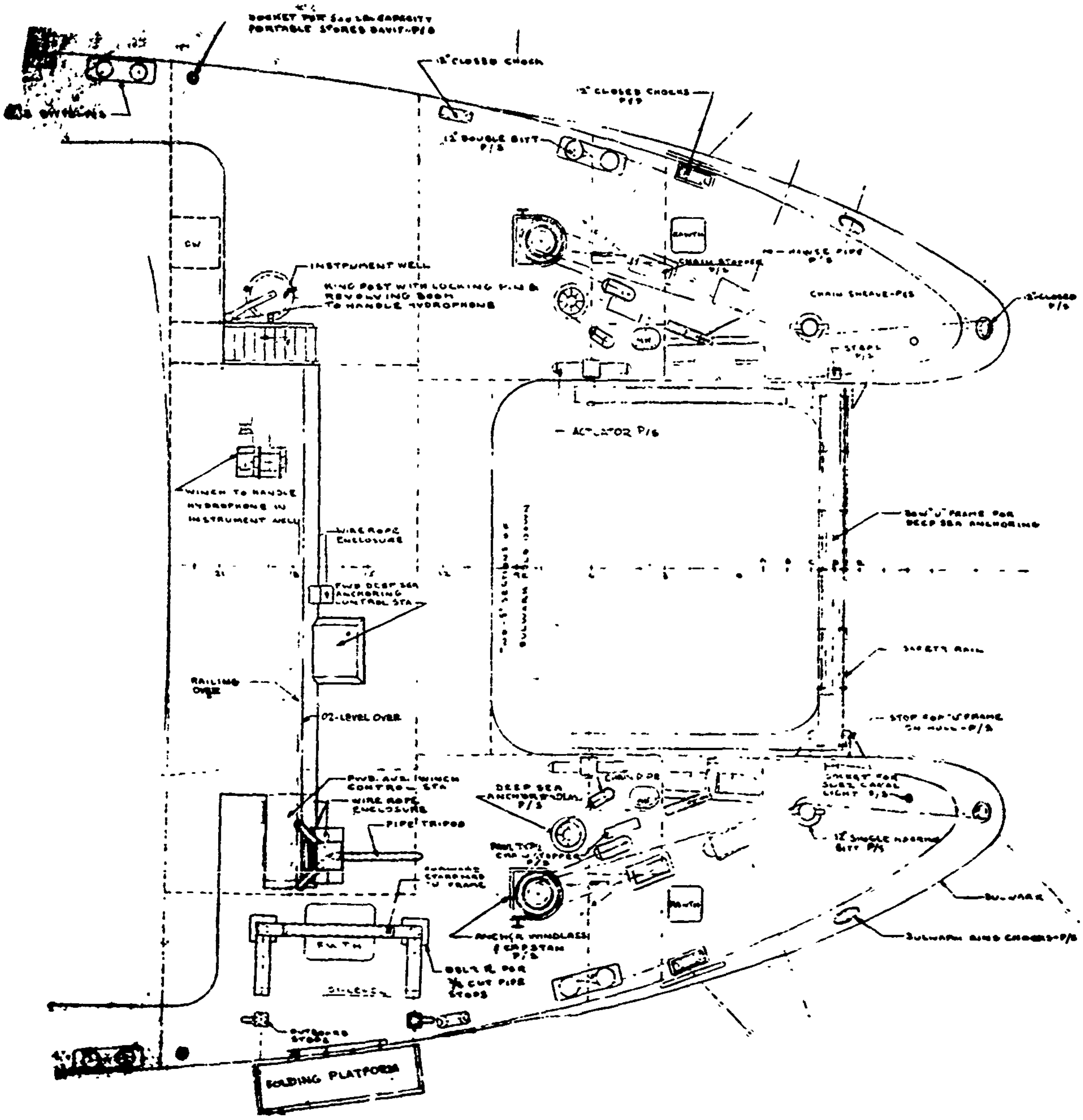


Fig. 49 - Forward Winch Complex -- Main Deck

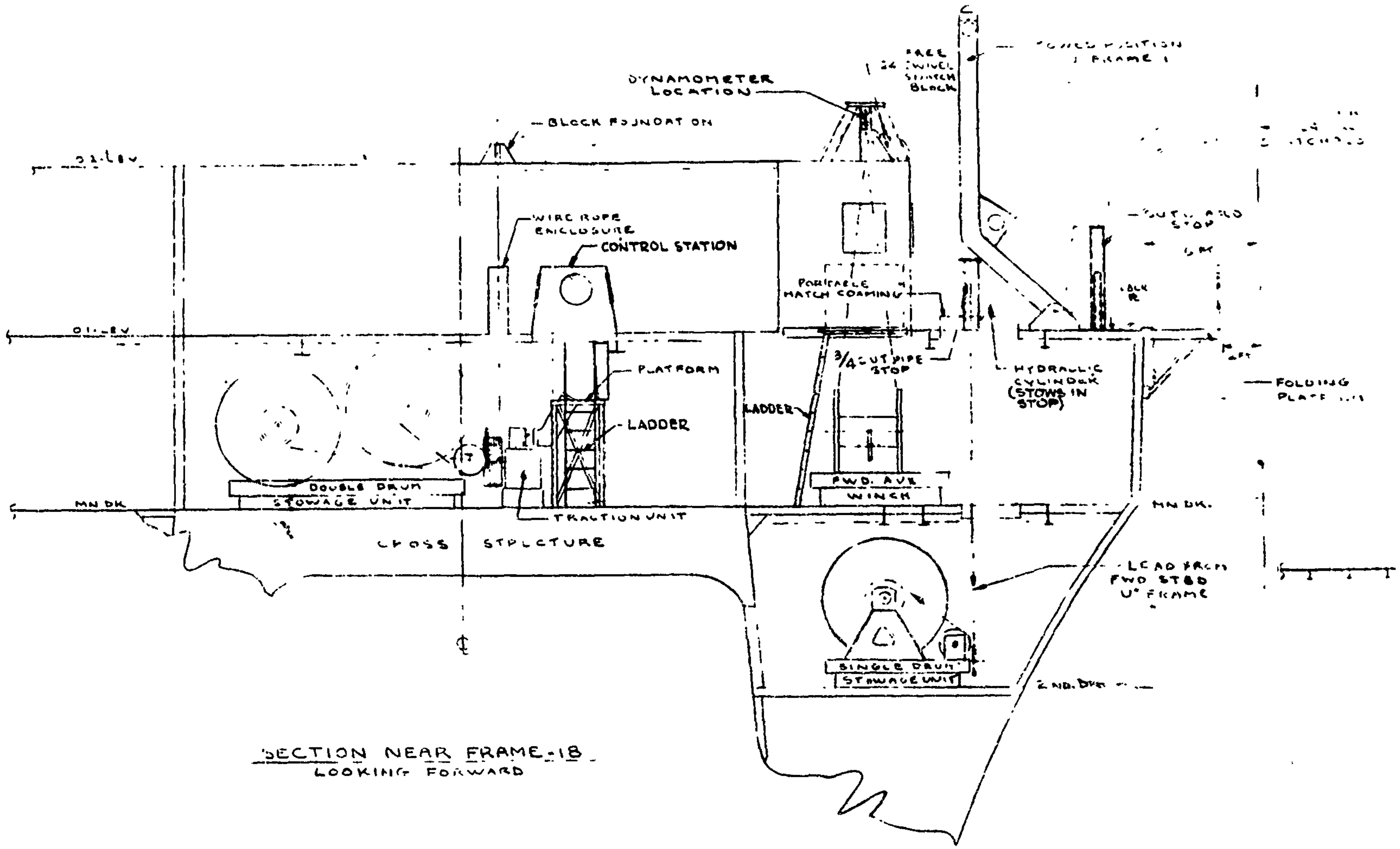


Fig. 50 - Forward Winch Complex -- Section Looking Forward

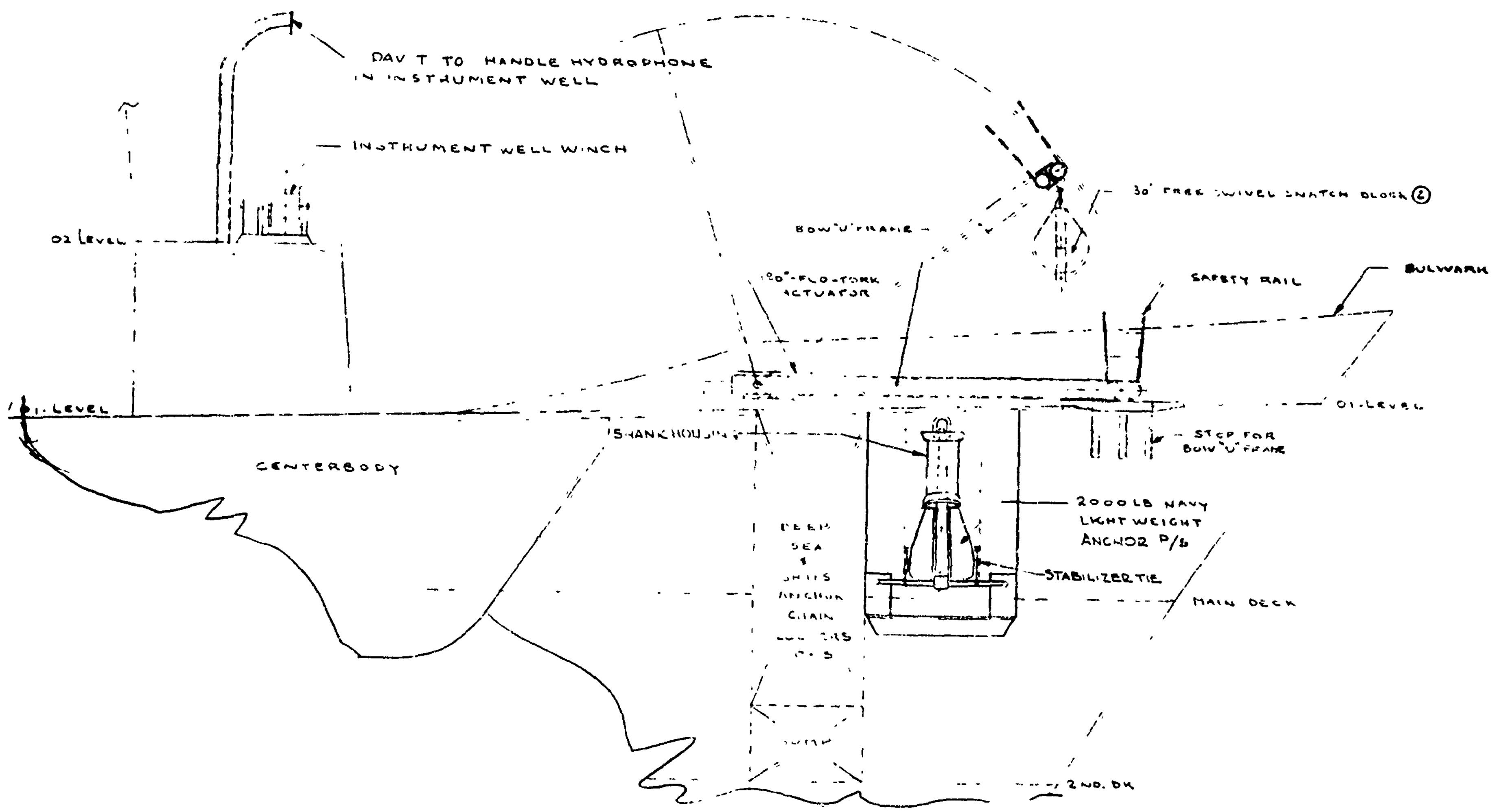


Fig. 51 - Port Hull -- Inboard Side Looking Forward

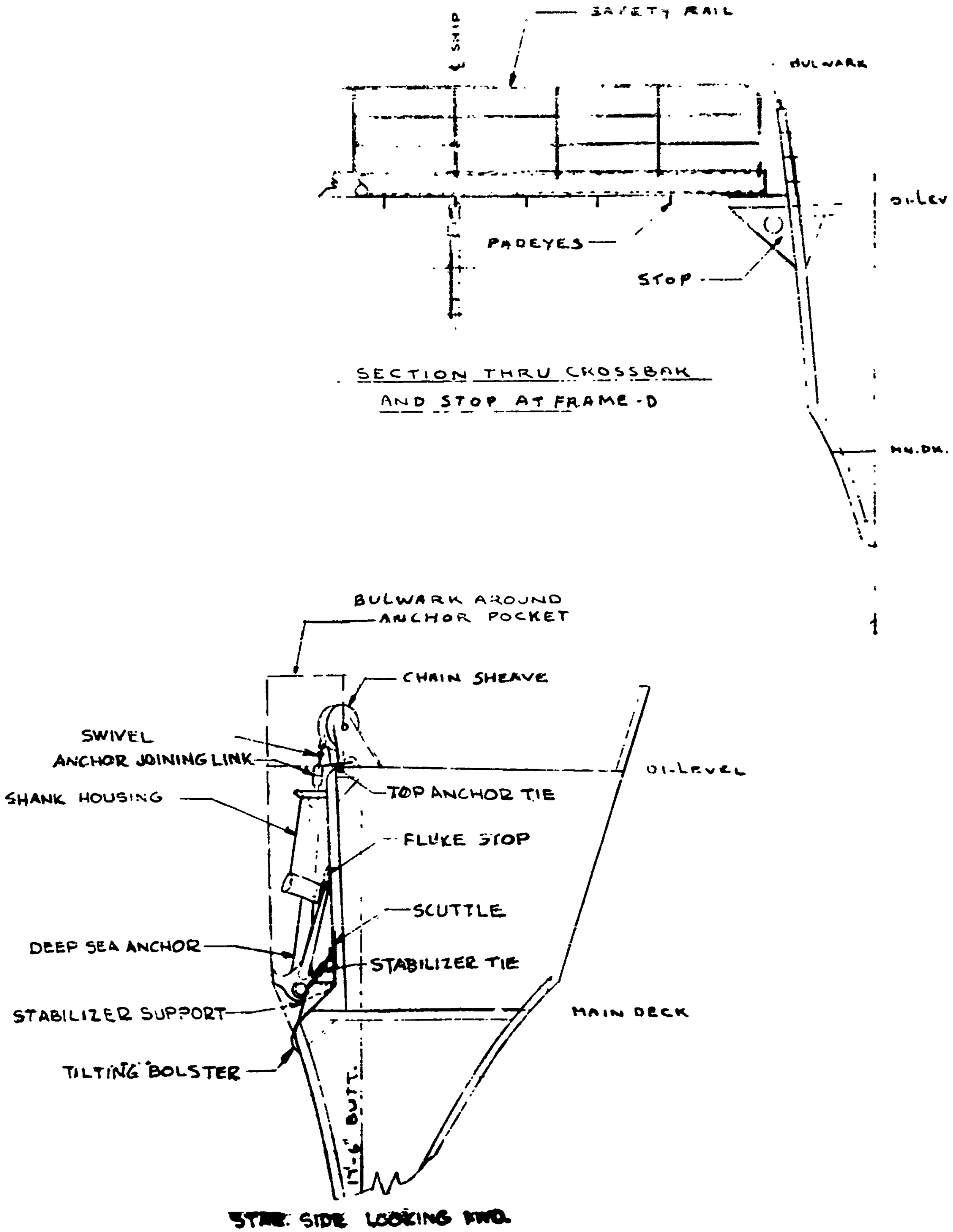


Fig. 52 - Bow "U" Frame and Deep Sea Anchor Details

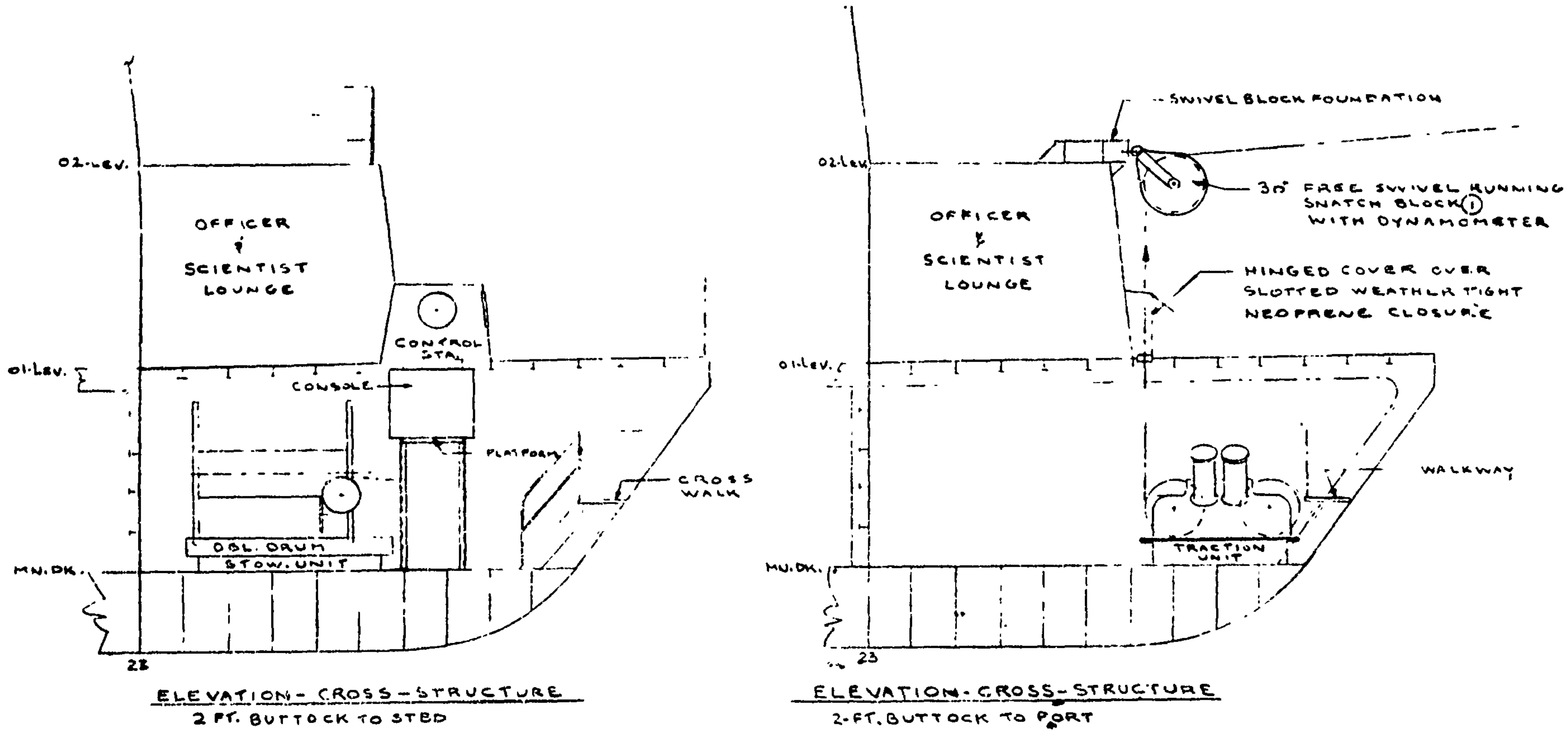


Fig. 53 - Forward Anchor Winch Details

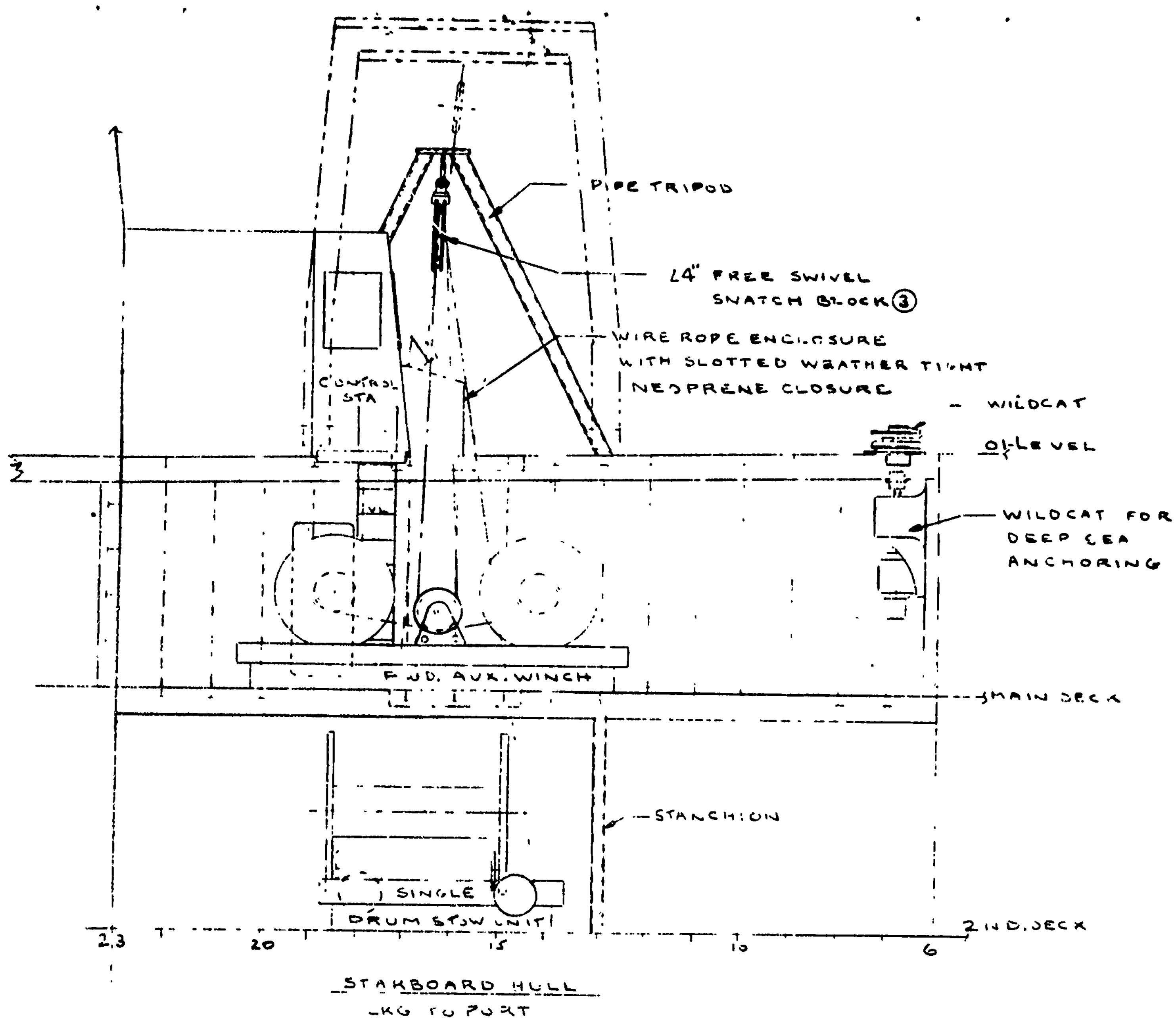


Fig. 54 - Forward Auxiliary Winch Details and Anchor Winch Single Stowage Drum

Figures 48 and 50 indicate how the wire rope is led from the dual drum stowage units to the traction unit and then up to a block at the 02 level shown in the right hand view of Fig. 53. The rope then proceeds to the snatch block hanging from the bow U-frame which is shown in Figs. 51 and 52. The single drum stowage unit is fairled up through two hatches to the starboard U-frame which serves the auxiliary winch forward. From this point, the rope is fairled to the 02 level swivel block and then below decks to the traction unit. It can be used for stripping one of the drums of the double drum unit or, in rare cases, could be used for overboarding light gear via the bow U-frame or starboard frame.

The primary use for the forward traction winch is for deep anchoring the vessel. The sequence of steps proposed for deep anchoring is as follows: One of the 2000-lb Navy lightweight deep sea anchors stored in pockets on the inboard surfaces of the two hulls (see Figs. 49, 51 and 52) is lowered by means of the deep sea anchor windlass until the connecting link joining two shots of chain appears opposite the access scuttle indicated in Fig. 52. The bitter end of the wire rope from the traction unit, which is fitted with an eye and a shackle, is led through the 30-in. diameter free swivel snatch block on the bow U-frame. Sufficient slack rope is paid out to allow the U-frame to rotate forward against its stops. At this point, the bitter end of the cable is carried over to the area of the scuttle and is shackled to the link joining the shots of chain by a man inboard of the scuttle. A walkway is provided on the bow U-frame for access to the sheave. When the shackle is secured, additional chain is paid out by the windlass until the wire rope has taken the load. At this point, the bow U-frame is swung aft and the wire rope hauled in until the link joining the

two sections of chain is at the 01 deck level just forward of the folding bulwark. A pad just off the centerline and aft of the bulwark is then utilized to support a strap and shackle which is connected to the link joining the two shots of chain. With the wire rope supporting the anchor, the link between the two shots of chain is unshackled, the end running to the hawse pipe being supported by the strap and padeye near the bulwark. At this point, the bow U-frame is swung out to a horizontal position against its stops and the wire rope is paid out and the ship is anchored. The reverse procedure is used in unanchoring. In unanchoring, the anchor flukes are tripped against the hull by a tilting bolster below each recess in the hull. The shank of the anchor fits into a housing and the anchor can be tied in using stabilizer ties shown in Fig. 52, which are secured by reaching through the scuttle.

The bow U-frame is actuated by two rotary hydraulic units. The structure will be capable of holding 50,000 lb when in the outboard position against the stops. The hydraulic system is specified as being capable of raising the frame while it is supporting a load of 15,000 lb and holding it in any intermediate position off the stops with this load. The transit time from outboard to inboard stop is specified as three minutes maximum.

The bow U-frame can be used for swinging heavy weights such as acoustic sound sources, etc. from the 01 deck to the slot between the hulls. Any heavy weight of this nature would have to be put in position by a dockside crane, although smaller sources can be brought forward by means of the starboard monorail which runs forward from the midship well area on the main deck level. Equipment can then be hoisted up through the hatch under the forward starboard U-frame and then can be skidded over to the bow U-frame area.

Figures 48, 50 and 53 show the control platform for the forward traction winch. A man standing on this platform is protected from the weather and yet has a good view of the bow U-frame and overboarding block, as well as the traction unit which is immediately below him. He has a fair view of the double drum stowage unit, but Hudson Laboratories had proposed using two men for operation of either of the traction winches for safety. The control station windows are provided with heaters and windshield wipers.

The forward auxiliary winch is a dual drum unit which shares the hydraulic power pack of the forward traction unit. It cannot be used simultaneously with the traction winch for this reason. This is not a major sacrifice, since the overboarding location for the two winches is so close that lines would probably tangle if simultaneous launchings were attempted. The location of the auxiliary winch and its fairleads and auxiliary equipment are shown in Figs. 48, 50 and 54. Both traction winches and all three auxiliary winches are similar, although in the latter case some concessions have been made to accommodate different wire sizes. Similar winches were specified to be products of the same manufacturer to reduce spare parts requirements to a minimum. The forward auxiliary winch is rated at 20,000 lb pull at 125 ft/min. and 5000 lb pull at 500 ft/min. This winch was to be used primarily for lowering acoustic sound sources, velocimeters, and other auxiliary equipment. It is sufficiently remote from the stern area that equipment may be launched from the forward U-frame while gear is being streamed from the stern without tangling. It is also possible to launch auxiliary equipment here while the ship is at anchor using the bow traction winch, since this wire rope tends to stream forward and the starboard auxiliary wire would tend aft if any current were encountered. This is not a recommended procedure in circulating wind areas.

The forward auxiliary winch rope is fairled up from the main deck to a tripod structure shown in Figs. 50 and 54. The rope can then be led over a snatch block hanging from the starboard U-frame. This U-frame has 10 ft of clearance between uprights at the base and 8 ft at the top with a minimum of 16 ft overhead clearance from the deck to the crossbar when the frame is in the stowed position. It is capable of sustaining a load of 20,000 lb in any direction when it is in the outboard position and is capable of transiting a load of 10,000 lb. The transit time from stop to stop is 30 seconds maximum. The U-frame is hydraulically actuated and replaces the motorized trolley and doors specified on page D-2 of Appendix D. The method of delivery of heavy equipment from the mid-ship area to the forward area has already been described. The forward auxiliary winch can also be fairled to the bow U-frame.

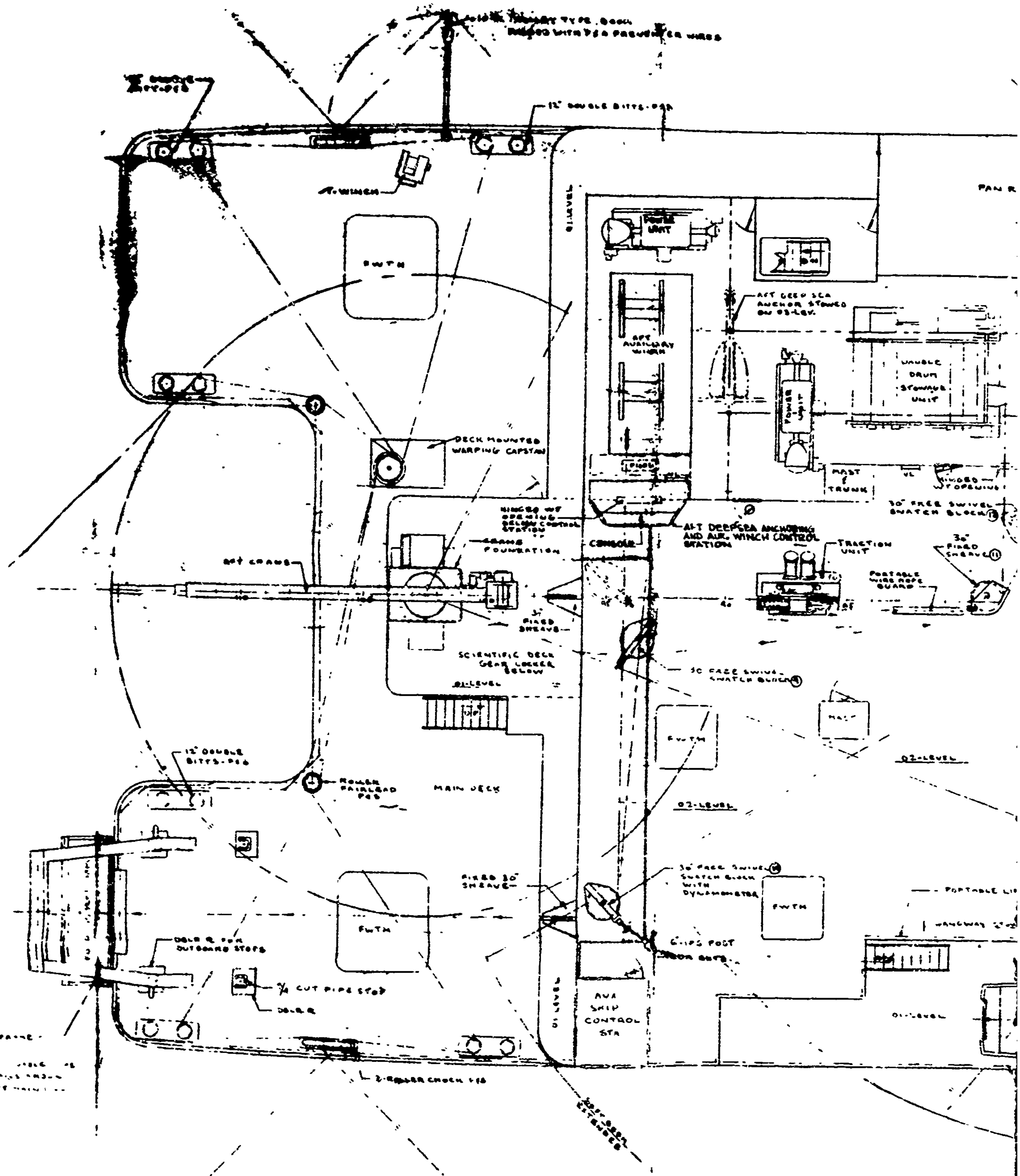
A folding platform is provided to be used in conjunction with the forward starboard U-frame, allowing access to within two ft of the wire rope when it is hanging vertically. This is necessary in order to fasten equipment along the length of the rope or cable as it is being lowered. An enclosed operating station shown in Figs. 49, 50 and 54 provides cover for the winch operator with an excellent view of the fairlead and overboarding blocks and the winch drums below. An access ladder between the winch compartment and the control station is provided. If only a terminal load is to be launched, one man can operate this winch once the load has been overboarded.

Figure 51 shows a davit mounted on the 02 level and instrument well winch which serves it. This is to be a 7 1/2 horsepower winch capable of pulling 7900 lb at 20 ft per minute. Tracking hydrophones with sectionalized arms can be lowered through this instrument well and the two wells in the midship area. These units can be used in a tracking or position determining system. Other

instruments may be lowered through these wells when the tracking hydrophones are not utilized.

B. Midship Section

Figure 55 is a plan view of the midship and stern handling gear. These two areas are actually completely integrated since it is possible to fairlead winches from one area to another. We have found this to be extremely important from past experience since it precludes the necessity of shifting cable from one winch to another. A number of winches are also capable of serving one overboarding station for launching complex systems requiring a variety of wire ropes and cable. Figures 56, 57 and 58 show the midship auxiliary winch and its associated equipment. The specifications for this winch are the same as for the forward auxiliary winch, except that this unit has its own power pack and one drum of the midship winch is to be fitted with an adapter which reduces the stowage capacity to 30,000 ft of 3/16 in. diameter hydrographic wire rope. By increasing the mean diameter of this drum, the mean line speed is increased. The dual stowage drums and power unit are located on the second deck. As shown in Fig. 58, the line from this winch is fairled up through the main deck to a block hanging on a fairlead structure and then runs to another block which hangs on a U-frame similar in specifications to the forward starboard U-frame. The vertical line of the rope passes two ft outboard of a folding platform, as shown in Fig. 56. A control station with a control console is provided with a view of the overboarding block and of the winch drums below. A ladder provides access from the control station to the winch compartment in order that one man may operate the winch once the terminal equipment has been launched. This winch can be fairled to the midship crane for launching equipment



AFT / MIDSHIP ARRANGEMENT

A

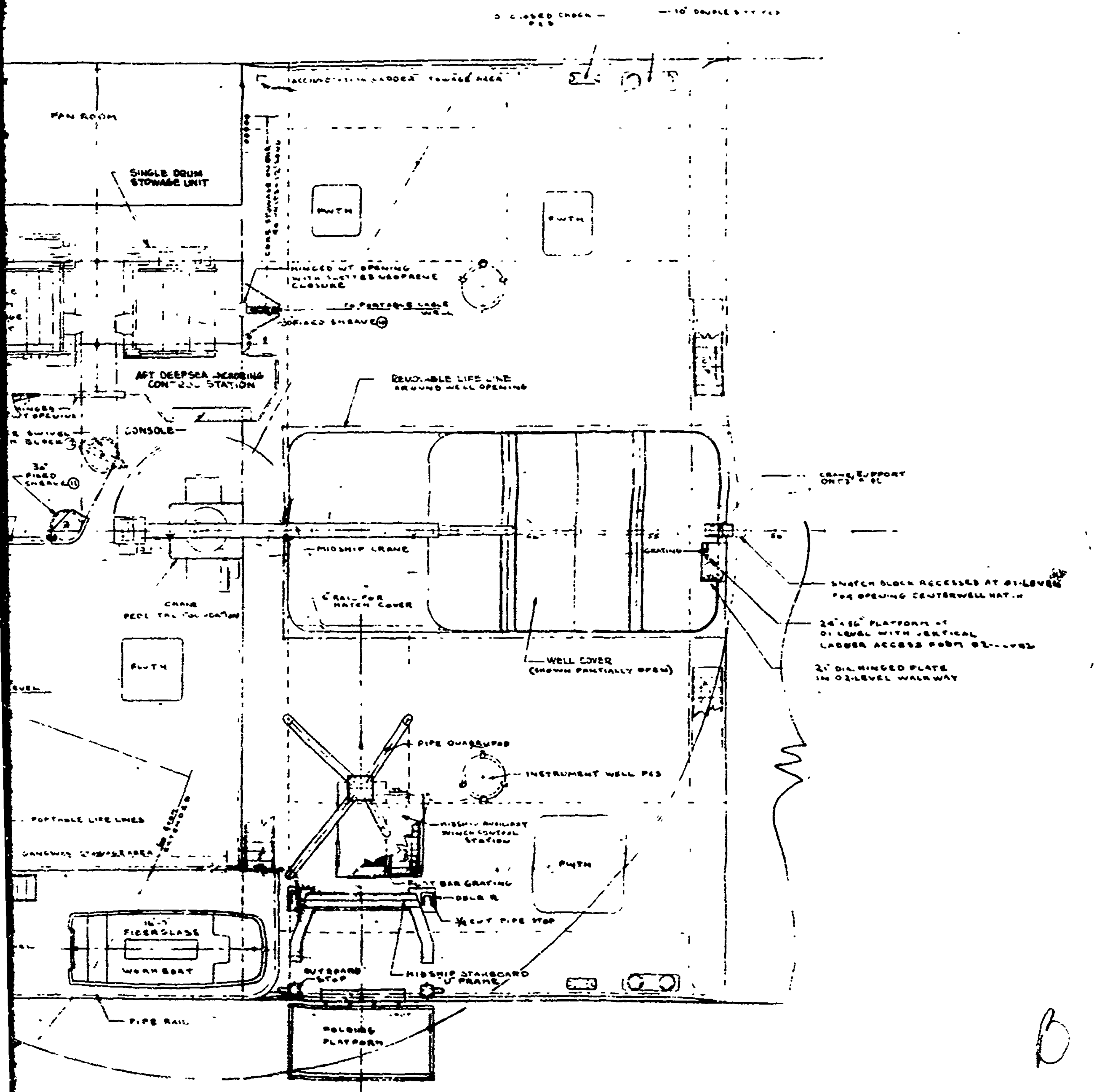


Fig. 55 - Midship and Stern Handling Gear

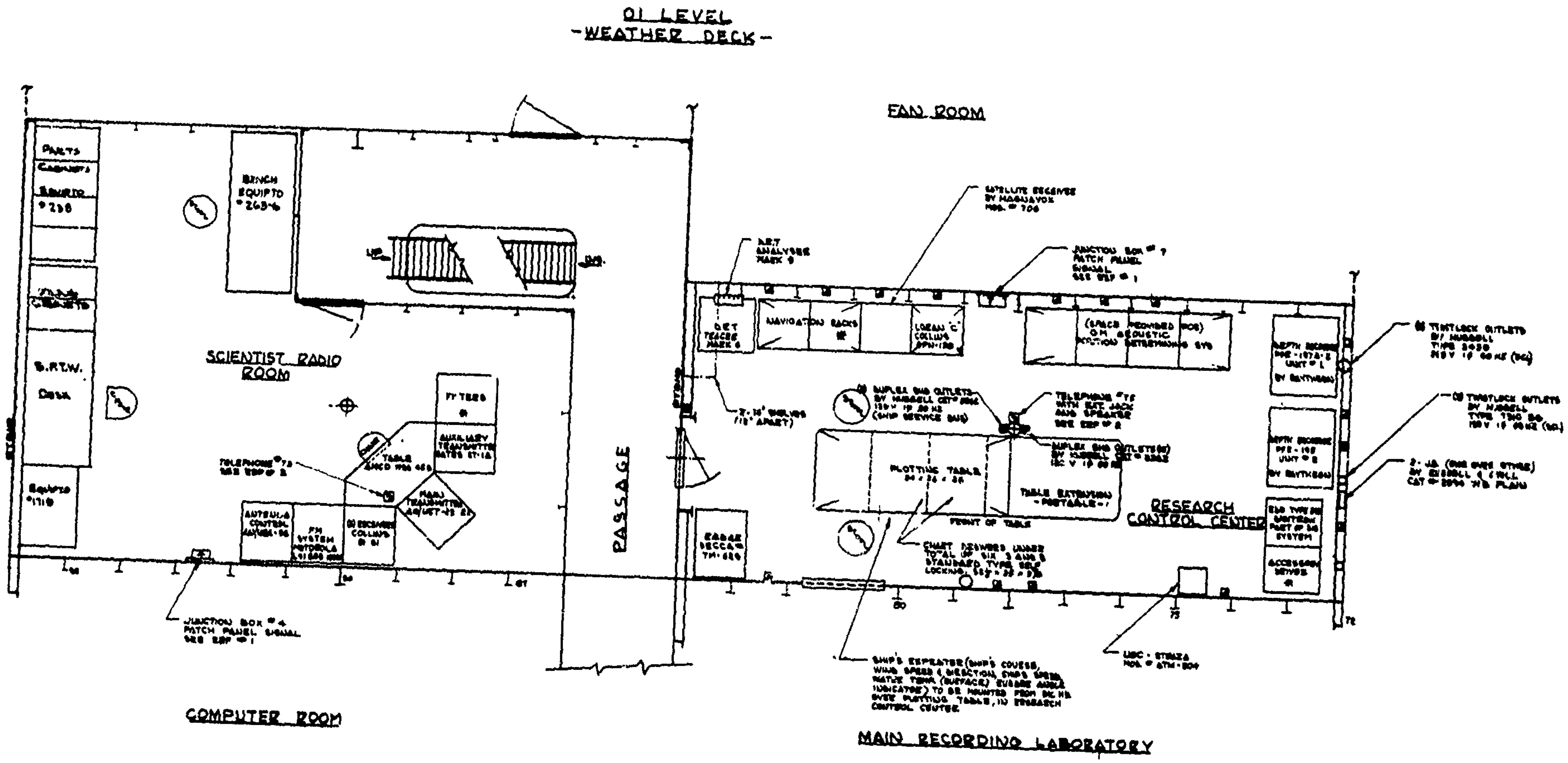


Fig. 56 - Midship Auxiliary Winch Section View Looking Aft

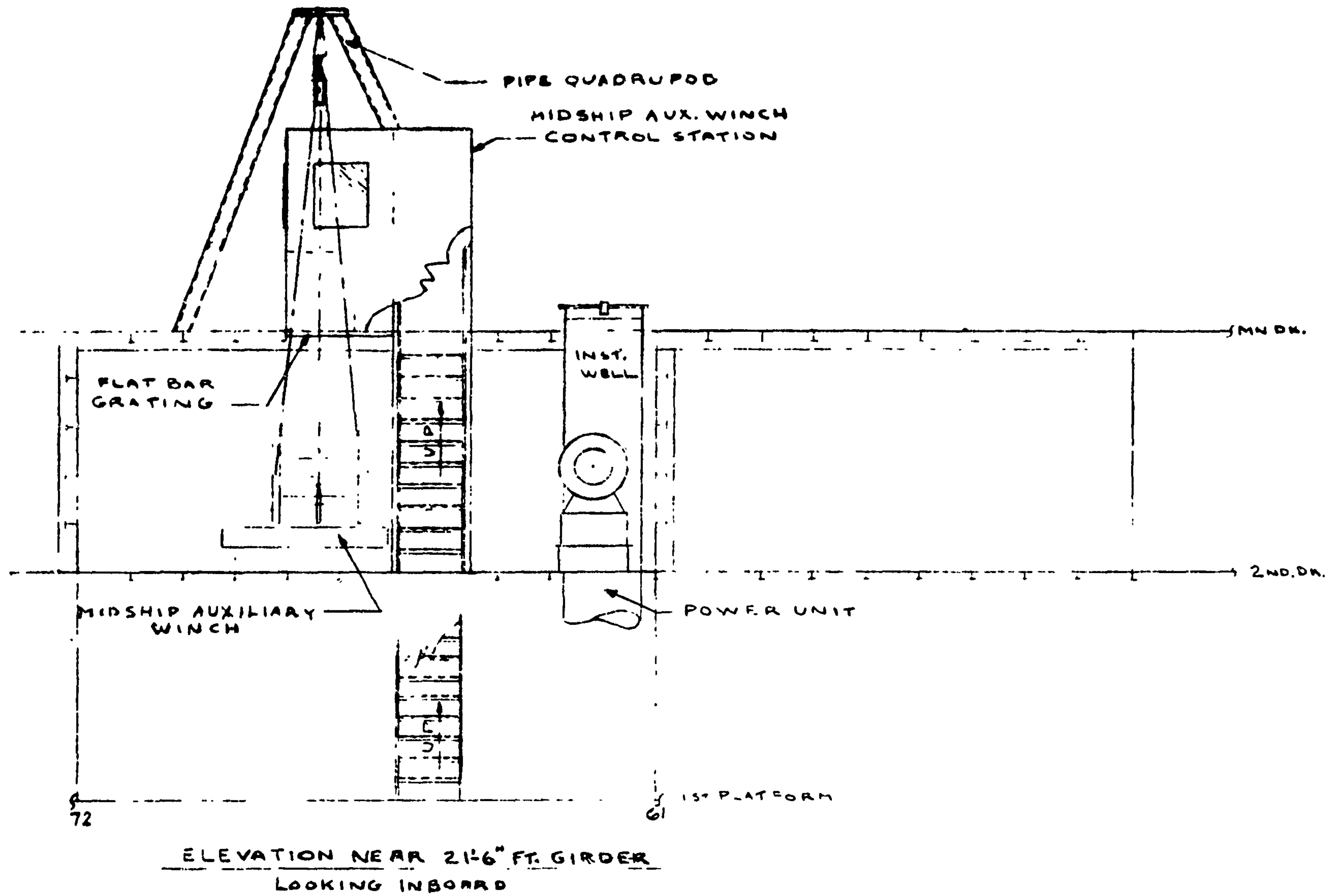


Fig. 57 - Midship Auxiliary Winch
Section View Looking Inboard

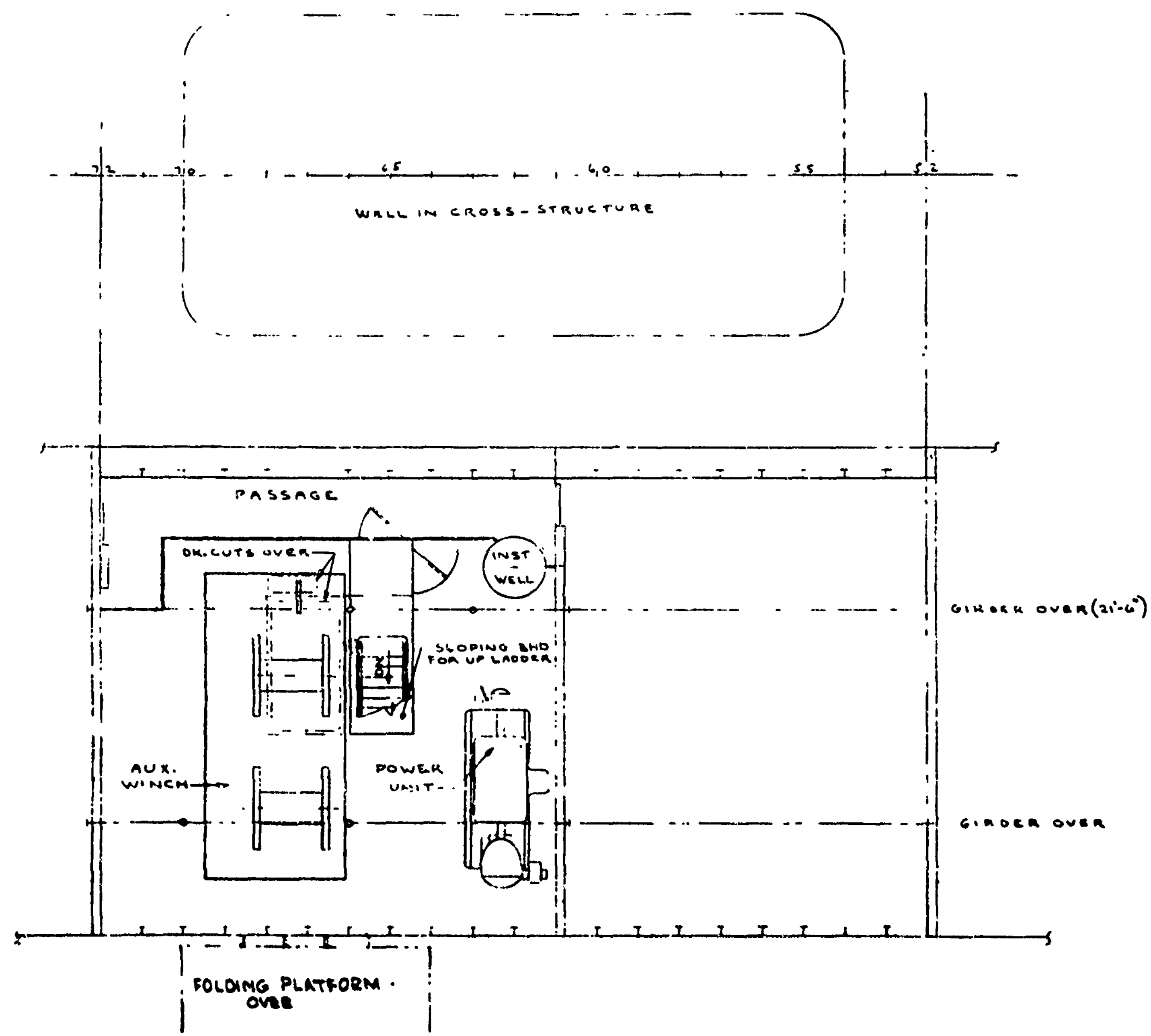


Fig. 58 - Midship Auxiliary Winch
Plan View of Second Deck

through the center well. In addition, it can be fairled through this crane aft to one of the overboarding stations in the stern area. The midship auxiliary winch main overboarding location is located just outside of the wet laboratory. It is proposed that water samples be taken at this station and that small and medium sized corers be deployed from this area.

Figures 55 and 59 show the midship rotating crane and the center well cover. Appendix D called for the installation of a 25-ton capacity traveling crane. In addition, a rotating crane of lesser capacity was required for loading purposes. These two units were replaced with a 25-ton rotating type crane. The specifications for this unit called for hydraulic actuation with a telescoping boom, similar to the Pettibone Mulliken multi-crane type, modified for marine use. This crane is rated at 50,000 lb with a 15-ft outreach and 8000 lb at a 60-ft outreach in the horizontal position. Provision will be made for passage of a 6-in. diameter by 12-in. long cable termination through the crane sheaves. Specifications call for this crane to operate from the horizontal to 70° above the horizontal. It is mounted on the 02 level of the after deckhouse and a crane boom support is provided at the 03 level on the forward deckhouse. Two straps are provided on the non-telescoping section of the boom on which it is planned to hang 30-in. diameter swivel snatch blocks for fairleading purposes. With the boom horizontal and tending forward, secured in the forward crane boom support, one of the hanging blocks can be used as a fairlead for lowering equipment through the center well. A two-part line arrangement using one block and a fixed eye can also be utilized for lowering equipment through the well.

The center well can be utilized for launching large acoustic sound sources with the additional potential of handling deep submersible research vehicles. It is recognized, however, that additional provisions will have to be

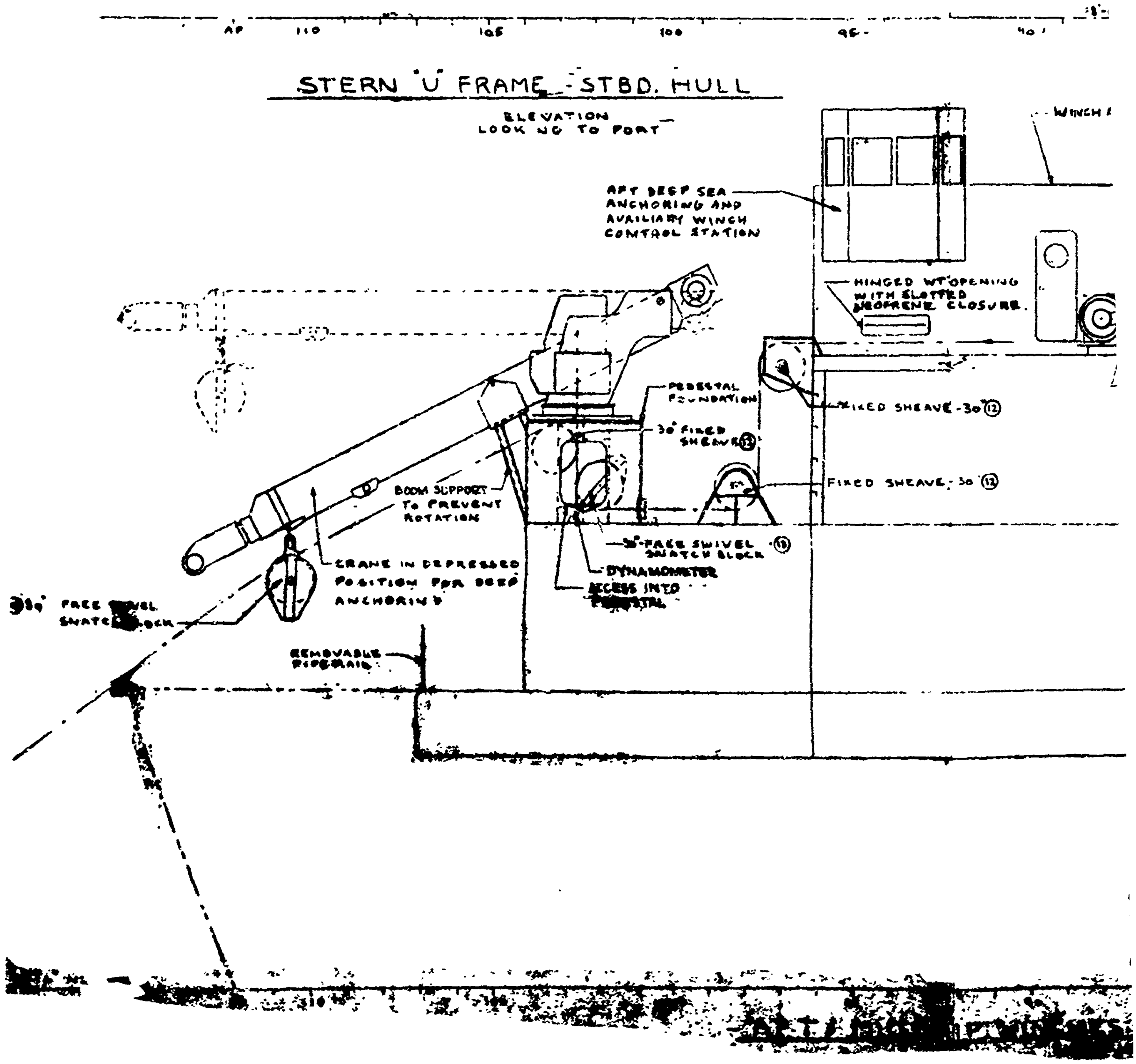
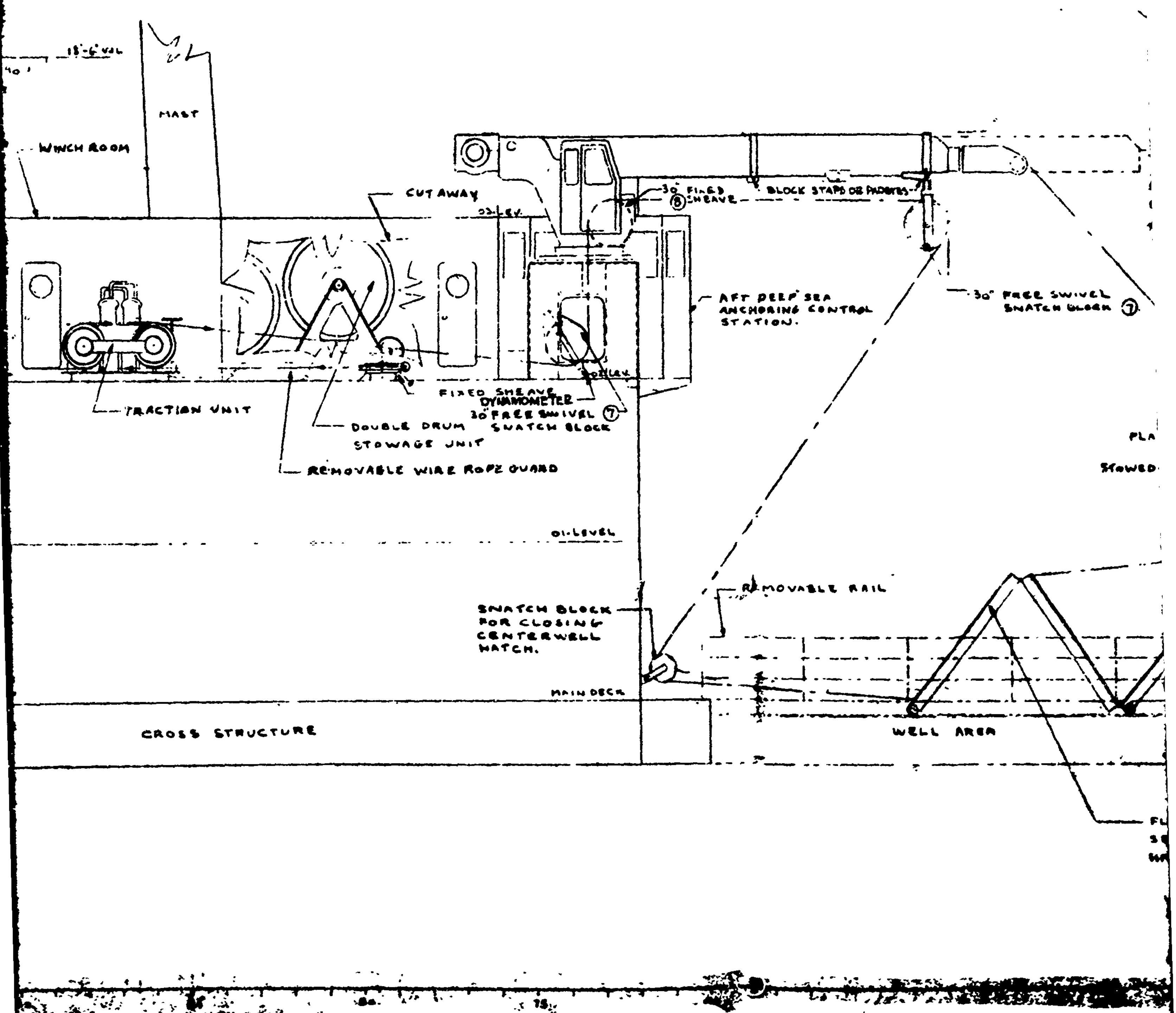
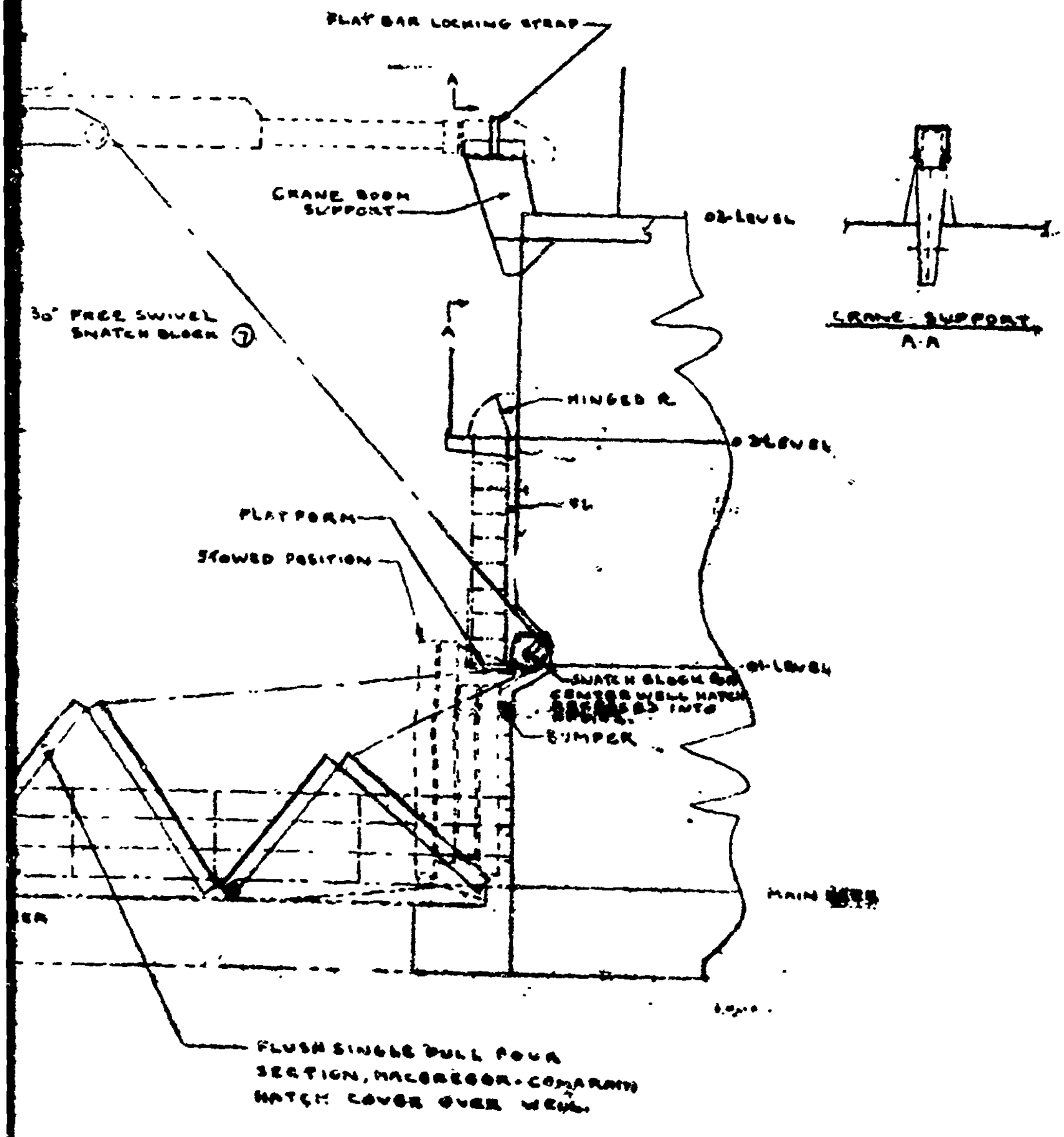


Fig. 59 - Midship and Stern Handling Gear Profile View



15'-6" VOL
MAST
WINCH ROOM
CUT AWAY
03-LEV.
30" FIXED SHEAVE ⑧
BLOCK STAPS OR PADEYES
AFT DEEP SEA ANCHORING CONTROL STATION.
30" FREE SWIVEL SNATCH BLOCK ⑦
TRACTION UNIT
FIXED SHEAVE
DYNAMOMETER
30" FREE SWIVEL ⑦ SNATCH BLOCK
DOUBLE DRUM STOWAGE UNIT
REMOVABLE WIRE ROPE GUARD
01-LEVEL
REMOVABLE RAIL
SNATCH BLOCK FOR CLOSING CENTERWELL HATCH.
MAIN DECK
CROSS STRUCTURE
WELL AREA
STOWED

B



FLAT BAR LOCKING STRAP
CRANE BOOM SUPPORT
02-LEVEL
30" FREE SWIVEL SNATCH BLOCK 7
A
A
HINGED R
FL
PLATFORM
STOWED POSITION
01-LEVEL
SNATCH BLOCK
CENTER WELL HATCH
BUMPER
MAIN
FLUSH SINGLE PULL FOUR SECTION, MACGREGOR-COMARAIN HATCH COVER OVER WELL
CRANE SUPPORT A-A

made for a deep retrieval system and tag lines necessary to preclude damage to such a vehicle. Very little effort was expended in developing such a system for the simple reason that we had never used a submersible nor were there any plans for Hudson to acquire such a vehicle in the immediate future. It was felt, however, that it would be inevitable that such a vehicle would have to be handled in the future, although our thinking and the history of our experience indicated that it might be best to handle such a device through the stern slot using the stern crane.

The midship crane serves as a fairlead for the after traction winch and after auxiliary winch. Rope or cable is fed to a pair of fixed sheaves, one of which is fixed to the stationary base of the crane and the other which is fixed to the rotating structure. The rope or cable between these sheaves runs on the center of rotation of the crane. Using one of the aforementioned winches and this crane, the folding door over the center well can be opened or closed as shown in Fig. 59. A control station for the after traction winch, located on the 02 level at frame 72, overlooks the center well area and also has a view of the 02 level of the after deckhouse.

The crane is to be provided with its own hydraulic winch capable of hoisting 15,000 lb at 60 ft per minute. It will have the capability of being rotated at a minimum rate of 1 rpm under rated load at the maximum outreach under a permanent list of 15° and a trim of 5°. Specifications call for it to be capable of being topped through an angle of 70° in not more than 50 seconds. A closed control cab with controls, windshield wiper, heater and communications is to be provided. In addition, a portable remote control unit capable of performing topping, telescoping, rotating and hook positioning tasks will be

provided. Figure 55 indicated the 60-ft radius which can be serviced by this crane. It is capable of reaching well over the side and can be used for loading the laboratory spaces through one of three flush watertight hatches shown on the 02 level. One of these hatches leads to the data processing room adjacent to the computer room, one leads to the starboard ladder well, and one to the main recording laboratory. In the midship well area, the crane is capable of servicing the large hatch in the overhead of the storeroom forward of the midship auxiliary winch, and the hatches leading to the shops in the port hull. This crane must be used to raise and lower hydrophones and other instruments through the two instrument wells located in the midship area. Use of this crane in conjunction with a similar after crane allows for transfer of heavy equipment from the stern area to the center well area, sequentially hoisting with each crane.

C. Stern Area

Components of the stern traction winch and stern auxiliary winch are located on the port side of the 02 deck in an enclosed room. Figure 55 shows the arrangement.

The stern traction winch is similar in specifications to the forward unit. A dual drum and single drum stowage unit and the power unit are located under cover. A hinged watertight opening is provided on the inboard bulkhead of the winch room, allowing cable access from the stowage units to the traction unit which is mounted on the ship's centerline on the weather deck. A 30-in. diameter fixed sheave is provided as a fairlead for the cable originating from the double drum stowage unit, and a swivel snatch block shown in phantom provides

a fairlead for the single drum unit when required. A padeye is provided on the deck for attachment of this block. The cable passes around the traction unit and can be led forward through the midship crane or aft over a series of fixed sheaves to the stern crane.

The after traction winch control station overlooking the center well area and the 02 level has already been mentioned. A second control console has been provided at the after end of the winch room which overlooks the stern area and the 02 level. The traction winch and the after auxiliary winch can be operated from this position. The vessel can be anchored from the stern if such a requirement arises and a deep sea anchor will be stowed on the 03 level over the winch room. The bulkhead at frame 72 above the 02 level will be provided with an opening to service the single drum stowage unit of the traction winch. Preliminary plans called for procurement of a portable back tensioning arrangement to service the traction winch to provide a cable laying facility aboard the catamaran. Using such an arrangement, many miles of cable could be laid on the bottom with a terminal array or by shifting loads, an array with intermittent hydrophones could be handled. Since funds were short, it was felt that the single drum stowage unit could be used as an alternate to the portable back tensioning unit and that cable could be fed through the hinged opening mentioned earlier and over the 30-in. fixed sheave shown in Fig. 55. This cable could be laid out on the midship well in a portable tank, positioned and secured at dockside. In discussing this with NAVSEC representatives, it was determined that 100 tons of cable could be readily accommodated without exceeding allowable deck loading or creating a stability problem.

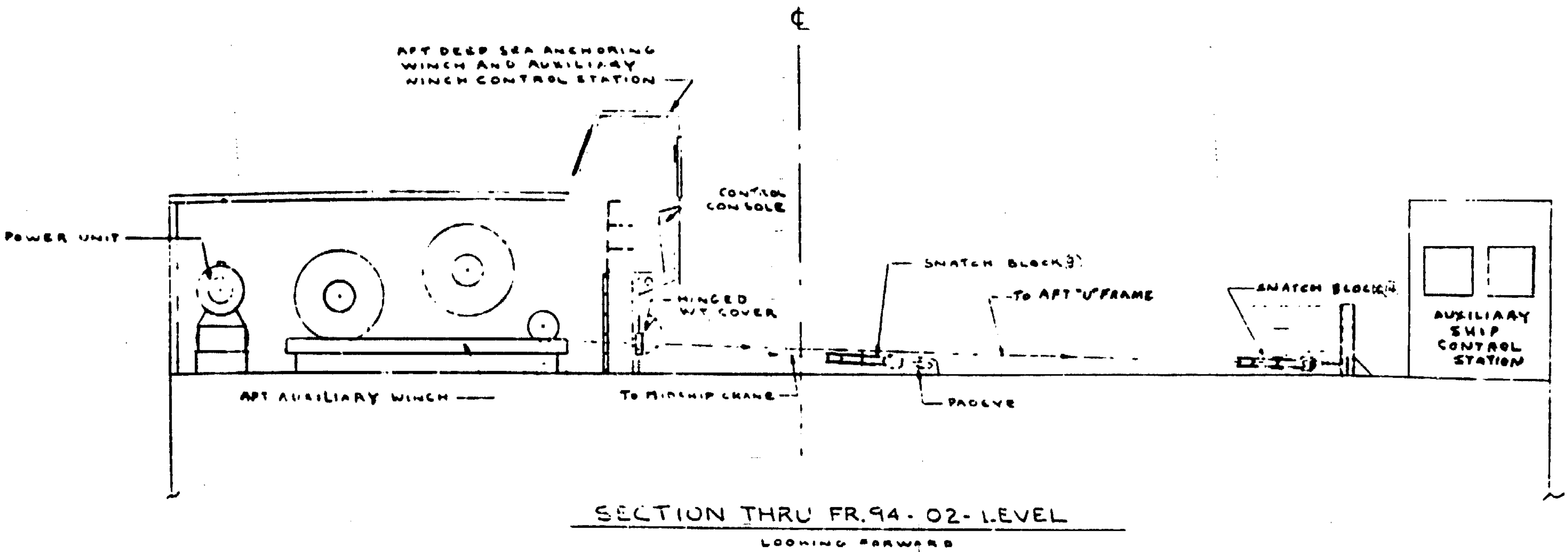


Fig. 60 - Fairleads -- 02 Deck

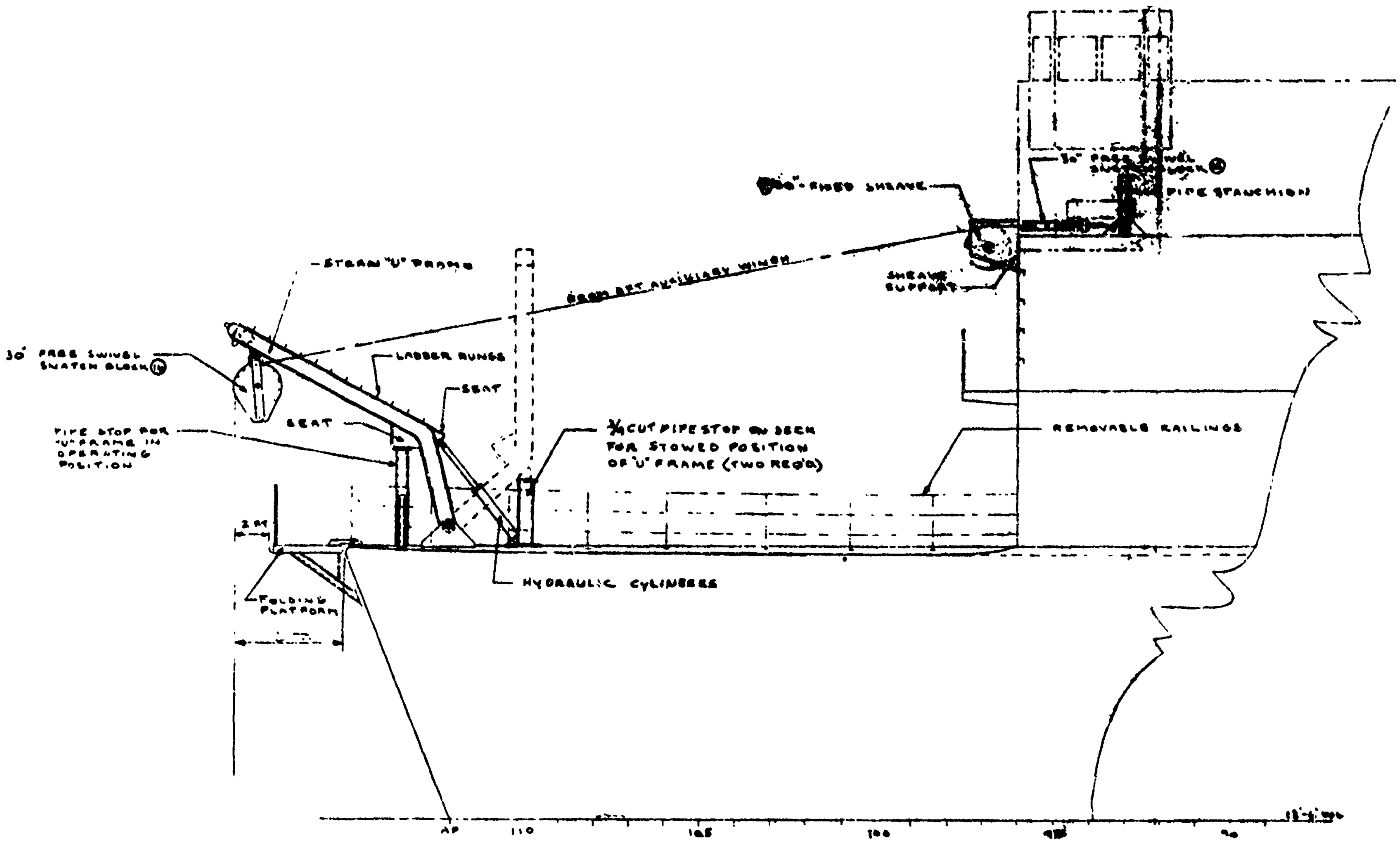


Fig. 61 - Fairleads -- Stern Area

The planned use for the two stern winches was primarily for the launching of acoustic sound sources and associated gear. In addition, large corers can be launched, deep towing operations can be conducted, and the ship can be deep anchored.

The stern crane specifications are similar to the midship crane specifications except that the after unit is to be depressable 30° below the horizontal. A boom support is provided at the 01 level and will be utilized when the crane is used as a fairlead for stern anchoring. The stern crane is capable of reaching well aft of the stern of the vessel under medium and light loads and can handle heavy loads through the stern slot. This area was to be the major overboarding area of the ship as far as the Hudson Laboratories engineers were concerned. Since the traction unit can be fairled through the after crane, this crane when rotated provides a fairlead for this winch to the stern U-frame mounted on the starboard hull. Because of the ready accessibility of the traction winch to this U-frame, the frame was specified as being capable of handling a 50,000 lb load in any direction and will be designated to transit a 15,000 lb load from stop to stop in no more than 30 seconds. A removable folding stern platform is provided under this U-frame. The after crane can be used for loading the storerooms in the port and starboard hulls below the main deck and will reach all three hatches on the 02 level of the after deckhouse. In addition, it can be used for overboarding shots of chain for deep anchoring and lengths of faired cable for towing operations.

A BT winch served by a 10-ft trolley boom is to be provided on the port hull aft.

D. General

The foregoing sections did not delve into all of the details of the handling gear relating to hydraulic specifications, cables and ropes, etc. This is adequately covered in the "Specifications For Building the Oceanographic Research Ship T-AGOR-16, Department of the Navy, Naval Ship Systems Command, 22 March 1968, as amended by Modifications 1, 2, and 3." Specifications are provided in this publication covering brakes, clutches, ratchets and pawls, bearings, bedplates, guards, sheaves, inspection holes, lubrication requirements, motors, etc., and will not be covered in this report. Continuity devices or slip rings were specified for most winch drums. These were to be manufactured from Hudson Laboratories drawings. The slip rings are made of fine silver and the wipers of gold. They are extremely quiet and can be used to transmit power. Alternate slip rings, providing a greater number of channels, can be easily installed in lieu of the units specified.

All major winches are to be provided with reduced voltage starters, line speed and feet out indicators, as well as dynamometers. Complete specifications were drawn up by Hudson Laboratories covering all wire ropes and cables to be used on every piece of handling gear. Testing procedures were outlined in the ship's specifications and provision has been made for testing deep sea anchoring equipment in the deep ocean as part of the acceptance trials.

Two major concerns were paramount in the minds of the Hudson Laboratories engineers. The first problem concerned funding. Since the basic ship and the scientific equipment were to be funded by two separate authorities, it was evident that slippage on the part of either one would create extreme hardships. For example, the installation of some of the heavy handling gear after the ship had

been completed would increase the cost of the total installation enormously. As of the date of this writing, this has in fact become a problem, and it is possible that the completed ship may have to be torn up in some areas for later installation. This is similar to the problems encountered aboard the USNS GIBBS when she was outfitted well after the conversion period.

The second major problem area concerns a possible division of responsibility during the installation of the handling gear. This was an extremely serious problem during the installation of the traction winch aboard the USNS GIBBS. In this case, responsibility for a satisfactory installation was not centered in one agency. The winch manufacturer, the installation yard, MSTS, BuShips (the procurement agency), ONR (the funding agency), and Hudson Laboratories all were involved. The net result was that Hudson personnel performed the trouble-shooting and debugging chores on this installation long after the manufacturer and shipyard had been paid off. In the case of the catamaran, we had hoped to be able to specify that each winch be installed on its own bed-plate with all piping between components of the winch to be done at the factory; thereby, centralizing the responsibility in the hands of the manufacturer. This was not possible, however, due to the size of the equipment. An attempt has been made in writing the specifications to centralize this responsibility in the hands of the construction shipyard or in the manufacturer's hand. Generally, one does not run into problems until the equipment has been operated for some period of time, so there is still a great residual concern that this equipment will have to be eventually debugged by the user.

X SCIENTIFIC ELECTRONIC EQUIPMENT, POWER LIGHTING, AND COMMUNICATIONS

A. Scientific Electronic Equipment

A list of the electronic equipment to be funded by operating funds and used primarily by the scientific user of the vessel follows:

ITEM	QUANTITY
Transducer, 3.5 kc	1
Bathymetric System, narrow beam with Digitrak and stabilized transducer	1
Navigation System (satellite receiver)	1
Loran C, automatic	1
Recorder, precision depth	2
Transmitter, synthesized, 1 kw 2-30 mc, SSB	1
Receiver, high performance, 2-30 mc	3
Coupler, automatic antenna (AN/URA-38)	2
Antenna, Fiberglass, 30 ft	3
Multi-coupler, receiver (RMC2x4)	1
Transmitter, crystal controlled, 1 kc, 2-30 mc, SSB, AM	1
Transceiver, FM (30-40 mc)	1
Teletype System (AN UGC-20) (AN URA-17)	1

The estimated procurement cost of this equipment without any allowance for future inflation was approximately $228,600. The spare parts and installation costs for this equipment were estimated at $70,400. This list of equipment is in basic

agreement with the approved catamaran specifications (see Appendix E). User supplied equipment will be covered in a later section.

The layout of the sonar transducers in the sonar dome located in the starboard hull forward is shown in Fig. 62. Provision has been made for pressurizing a watertight trunk above these heads so that they may be removed and serviced at sea by scuba divers operating from within the ship.

B. Scientific Power

Two shock mounted, diesel driven, 75 kw scientific generators will be provided. These generators will be mounted high on the forward deckhouse adjacent to the stacks to reduce noise radiated to the water. These machines are to be 450 volt, 3 phase, 60 cycle units capable of parallel operation. The sensitivity of the voltage regulators is specified as $\pm$ 1/2 percent. Hudson Laboratories established the location of all ship service and scientific power outlets in all of the laboratory spaces.

C. Internal Communications and Data Signal Distribution Systems

Figure 63 is a block diagram of the scientific internal communications circuits. Dial telephone hand sets are to be provided in all laboratories, shops and public rooms frequented by the scientific party. In addition, phones are to be provided on the bridge, several of the scientific staterooms, the Master's office and the gangway, port and starboard. Highly directional microphones and loud speaker units are to be provided at high noise areas, such as winch control stations, crane cabs, overboarding areas, and in the recording laboratory, electronics laboratory, and mechanical engineering shop. In addition, units of this type will be provided at the gangway. The loud speaker and microphone

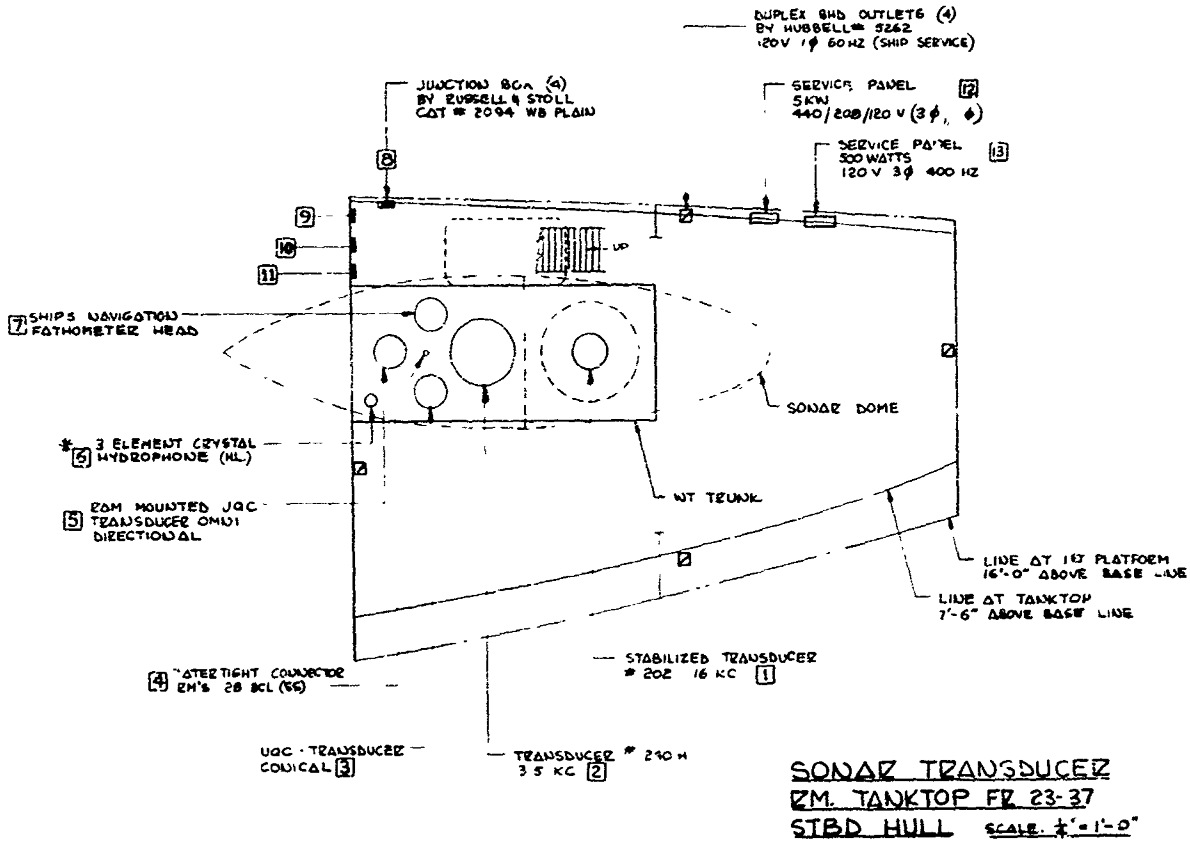
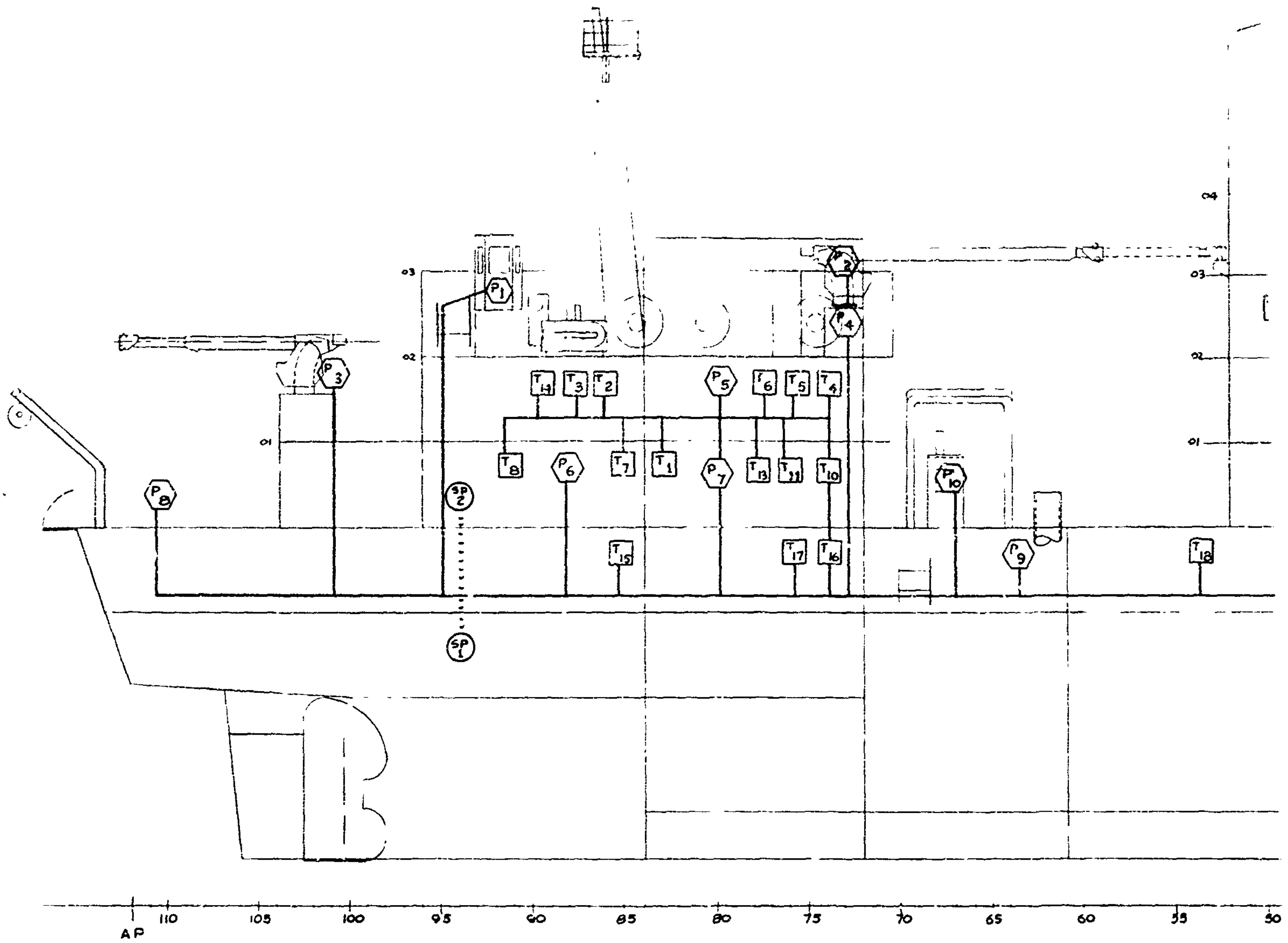
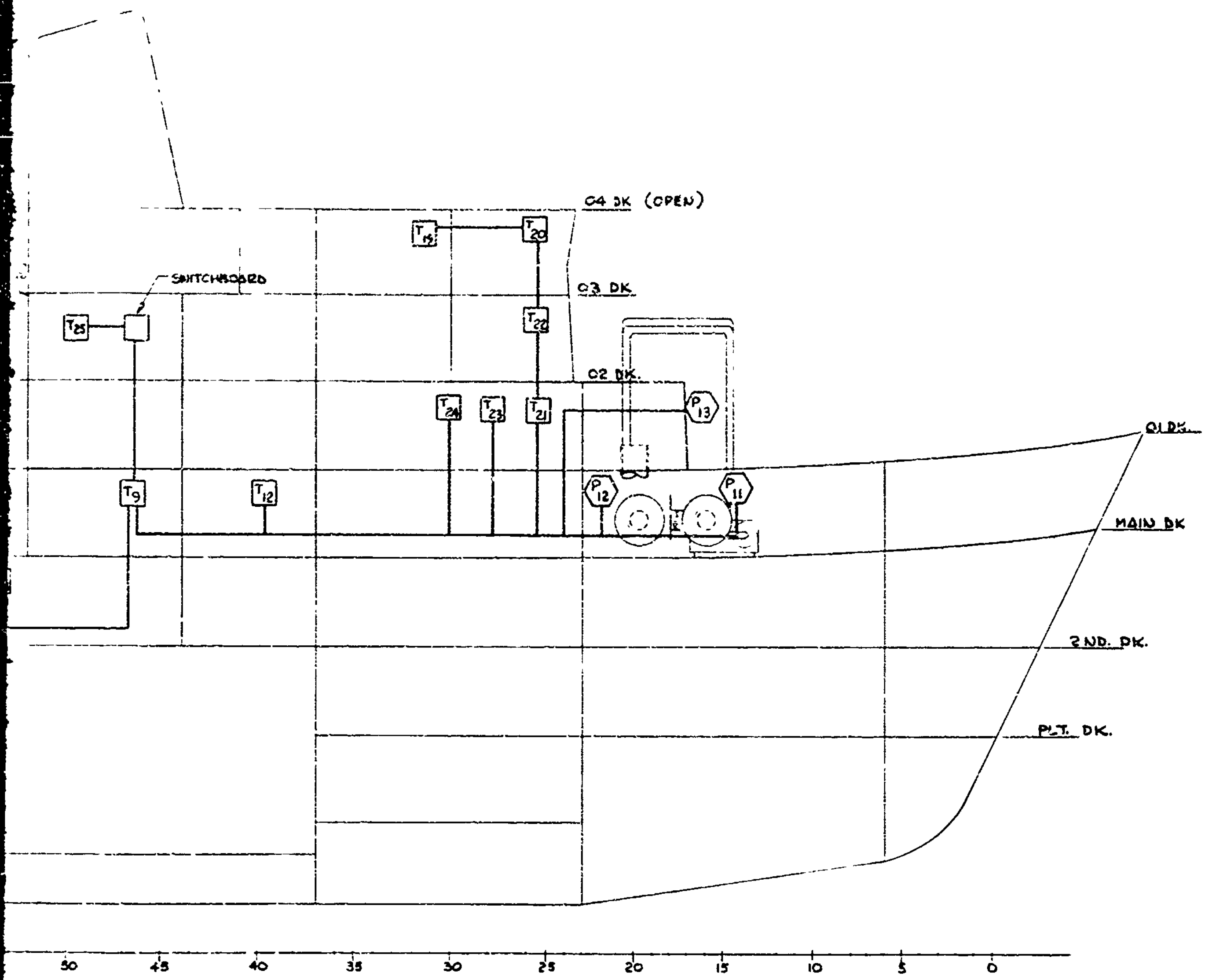


Fig. 62 - Layout of Sonar Transducer Room



	TELEPHONE - HANDSET - [T]		LOUDSPEAKER & MIKE (P)		TELEPHONE — SOUND-POWER
1	DATA PROCESSING LAB #2 MAIN DK FR 80-84 PT	1	AUX. WINCH CONTROL STATION 02 DK FR 90-93 PT	1	DEMOLITION CHARGE MAG. 1ST PLT. FR 84-9
2	COMPUTER RM 01 DK FR 86-96 PT.	2	MN. ANCHOR WINCH CONTROL STA. AFT 02 DK FR 71-76 PT	2	R S ROOM MAIN DK FR 91-96 PT
3	SCI. RADIO RM. 01 DK FR. 86-96 PT.	3	CRANE CAB 01 LEVEL FR 103 ℄		
4	MAIN REC. LAB. 01 DK FR 72-84 ℄	4	CRANE CAB 02 LEVEL FR 74 ℄		
5	RESEARCH CONTROL CENTER 01 DK FR 72-84 PT	5	MAIN REC LAB 01 DK FR. 72-84 ℄		
6	ELECT. SHOP #1 01 DK FR 72-84 STBD	6	MECH. ENG SHOP. MN DK FR 84-96 ℄		
7	PERSONNEL DAY RM #2 MN. DK. FR 86-96 PT	7	ELECT. LAB. MN. DK. FR. 72-84 ℄		
8	ME CALIBRATION & TEST LAB. MN DK FR 89-96 STBD	8	U FRAME AREA MN. DK. FR 110 STBD		
9	ENG. OPER. STATION. MN DK 44-52 ℄				
10	WET LAB. MN. DK. FR 72-84 STBD				
11	ELECT. LAB. MN DK. FR 72-84 ℄	9	AUX WINCH RM. 2ND DK FR 61-72 STBD		
12	SCI. & OFFICER MESSROOM MN DK FR. 37-44 PT.	10	AUX WINCH CONT. STA. MN DK. FR 67 STBD		
13	ELECT SHOP #2 (AMP) MN DK FR 72-80 PT	11	FORWARD WINCH RM MN DK FR 13-23 ℄		
14	DATA PROCESSING LAB #1 01 DK FR 86-96 STBD	12	FORWARD AUXILIARY WINCH RM MN DK FR 13-23 STBD		
15	SCI OFF. & LIBRARY 2ND DK FR 84-96 PT	13	DEEP SEA ANCHOR CONTROL STATION 01 DK FR 17 ℄		
16	PERSONNEL DAY RM #1 2ND DK FR 72-84 PT				
17	PHOTO LAB. 2ND DK. FR. 72-84 STBD.				
18	GRAVITY METER RM 2ND DK FR 52-56 STBD				
19	SHIP'S RADIO RM. 03 DK FR. 30-37 ℄				
20	BRIDGE 03 DK FR 24-30 ℄ AND QUARTER DK PT & STBD				
21	CHIEF SCI. SR & OFF 01 DK FR. 23-33 PT				
22	MASTER'S OFF. 02 DK FR 23-30 STBD				
23	SCI SR. 01 DK FR 33-37 PT				
24	OFFICER & SCI. LOUNGE 01 DK. FR 17-23 ℄				
25	I C GYRO ROOM 02 DK. FR 46-52 ℄				

Fig. 63 - Scientific Internal Communications Circuits



POWER (SP)
LT FR 84-96 P
PT

NOTES :- POWER INTERCOM CABLE RECOMMENDED :-
IC-TDX-400-MFD
AUTOMATIC TEL COMM. SYS. WITH HIGH LEVEL CONFERENCE

2. TELEPHONE, LOUDSPEAKER & MIKE ARE SUBJECT TO RELOCATION
AS VARIOUS COMPARTMENTS AND ANCHORING MACHINERY ARE RELOCATED

B

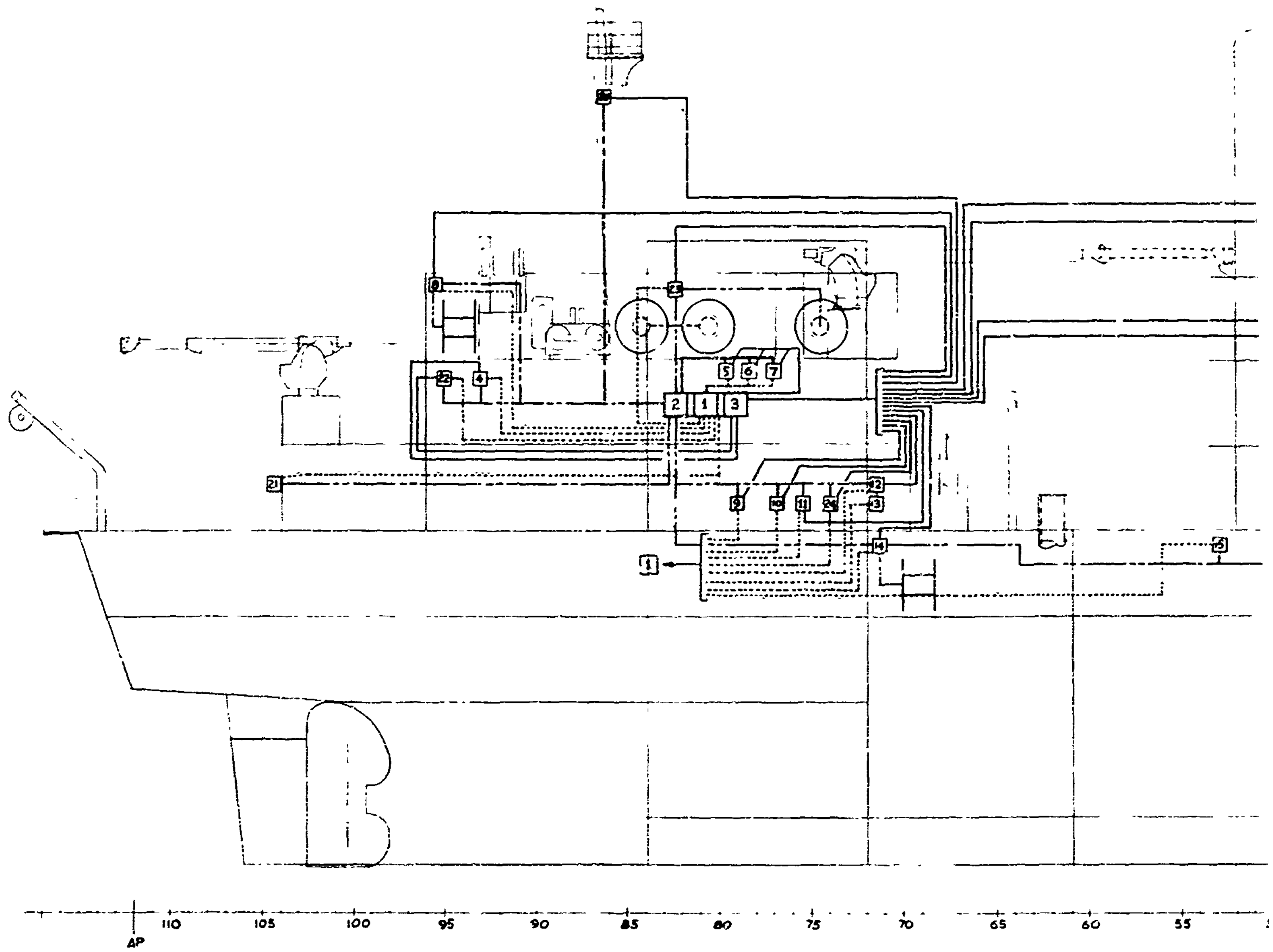
system is to be fully integrated with the telephone hand set system and provision is to be made for a minimum of five simultaneous conversations on these circuits without interference with other stations. Sound power telephones have been specified for communications between the magazine and handling room areas.

Figure 64 illustrates the scientific data distribution system. Provision has been made for junction boxes at each of the data collection stations such as adjacent to winch slip rings, overboarding areas, instrument tubes, gravity meter room, etc. These signals can be fed to the major laboratories in the after deckhouse and to the computer room. Detailed wiring diagrams of the junction boxes were prepared by Hudson Laboratories. Patch boards are provided in laboratory areas for introduction of data to electronic processing equipment or for patching in of navigational information, etc., to the computer room. The master signal distribution panels are located in the electronics shop on the 01 deck. Provision has been made for use of closed circuit television with this data distribution system.

The power distribution system, which provides power to winch slip rings from the amplifier room in the after deckhouse, has already been described and no figure will be presented in this report.

D. Lighting

Figures 65 and 66 show the plan view of the open deck lighting system and the outboard profile view of the same, respectively. All the flood lights indicated on the figures are 500 watt units except for those at the end of the rotating cranes which have been specified as 1000 watt units.



	JUNCTION BOX #	COMPARTMENT	COMPARTMENT LOCATION	JB WIRING DIAG. HUDSON LAB DWG #	JB CONSTRUCTION HUDSON LAB DWG #	JB LOCATION SEE HUD. LAB. GEN ARR. DWG #
MASTER SIGNAL DISTR PNL. (PATCH BOARD SECT.)	1	ELECT SHOP # 1	01 DK. FR 72-84 STBD	2125 WO (SHEET 1)		CAT - C - 2 - 19
MASTER SIGNAL DISTR. PNL (RF SECTION)	2	ELECT " "	01 DK FR 72-84 STBD	2125 WO (SHEET 2)		CAT - C - 2 - 19
MASTER SIGNAL DISTR PNL (VIDEO SECTION)	3	ELECT. "	01 DK FR 72-84 STBD	2125 WO (SHEET 3)		CAT - C - 2 - 19
	4.	SCI RADIO RM	01 DK. FR 86-96 PT	2125 W 1		CAT - C - 2 - 17
	5	MAIN REC LAB	01 DK FR 72-84 ℄	2126 W 4		CAT - C - 2 12
	6	MAIN REC LAB	01 DK FR. 72-84 ℄	2126 W 3		CAT - C - 2 - 12
	7.	RESEARCH CONT CENTER	01 DK FR 72-84 PT.	2125 W 5		CAT - C - 2 - 17
	8	AFT AUX WINCH RM	02 DK FR. 93-96 PT.	2126 W 14		
	9	ELECTRONIC LAB	MAIN DK. FR 72-84 ℄	2126 W 9		CAT - C - 2 - 15
	10	ELECTRONIC LAB.	MAIN DK FR 72-84 ℄	2125 W 10		CAT - C - 2 - 15
	11	ELECT SHOP #2 (AMP)	MAIN DK. FR 72-84 PT.	2125 W 6		CAT - C - 2 - 20
	12	INSTRUMENT TUBE	MAIN DK FR. 62 STBD	2125 W 13		
	13.	INSTRUMENT TUBE	MAIN DK FR 62 PT.	2126 W 12		
	14	MIDSHIP AUX WINCH RM	2 ND DK. FR. 61-72 STBD	2125 W 18		
	15	GRAVITY METER RM	2 ND DK. FR. 52-56 STBD	2126 W 17		
	16.	DOUBLE STAND BEAM - WINCH RM	MAIN DK FR 13-23 ℄	2125 W 15		
	17	AUX WINCH RM	MAIN DK FR. 6-23 STBD	2126 W 8		
	18	INSTRUMENT TUBE	MAIN DK FR 21 PT	2126 W 16		
	19	BRIDGE (PILOT HOUSE)	04 DK FR 23-30 ℄	2126 W 11		
	20	AFTER MAST	FR 85	2125 W 19		
	21	FANTAIL DK	MAIN DK FR 95 ℄	2126 W 20		
	22	COMPUTER RM.	01 DK. FR. 86-96 PT	2125 W 2		CAT - C - 2 - 10
	23	MAIN ANCHOR WINCH RM	02 DK FR 72-85 PT	2125 W 7		
	24	WET LAB	MAIN DK. FR. 72-84	2125 W 21		CAT - C - 2 - 21

LEGEND

2 1 3 MA

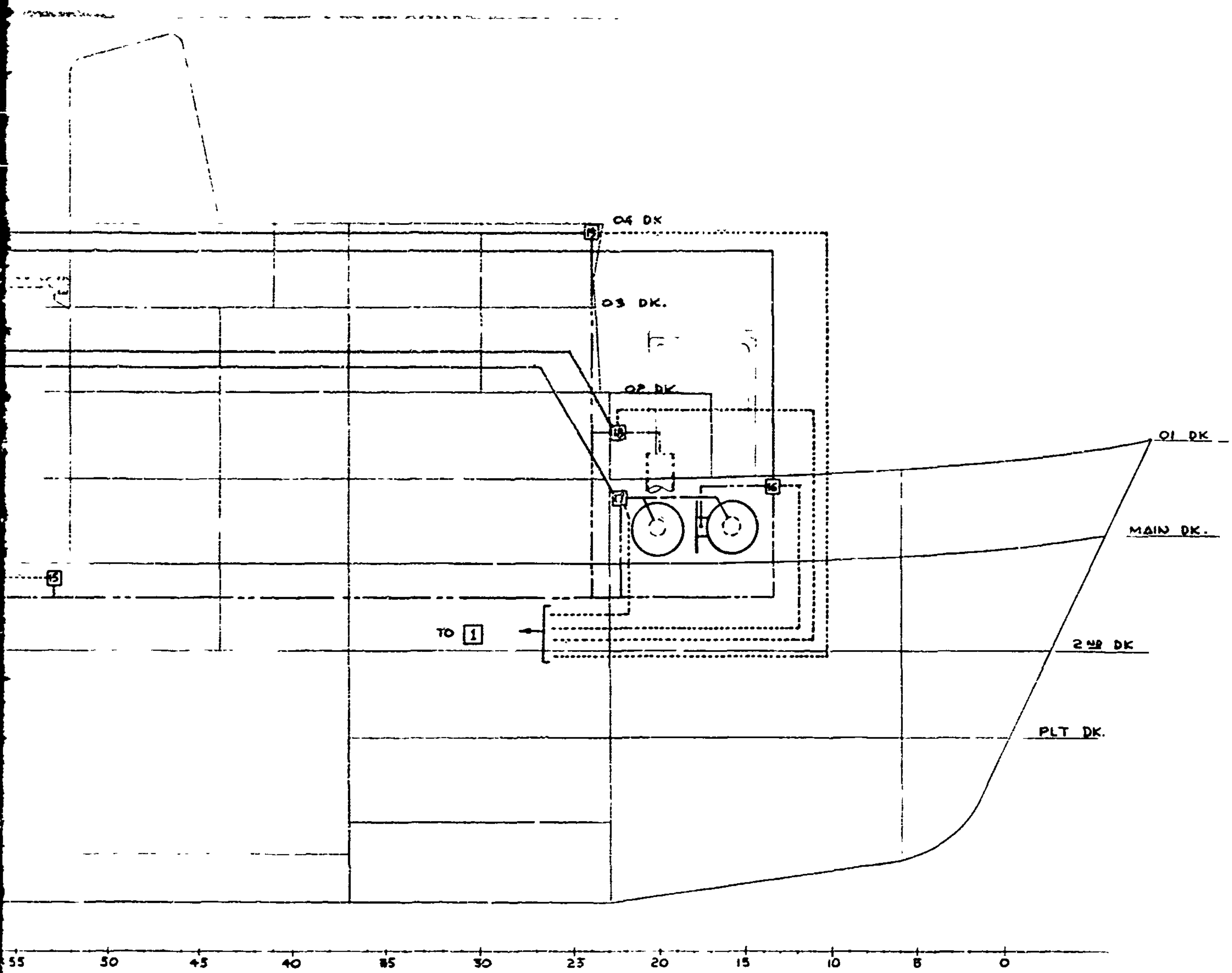
2

1

3

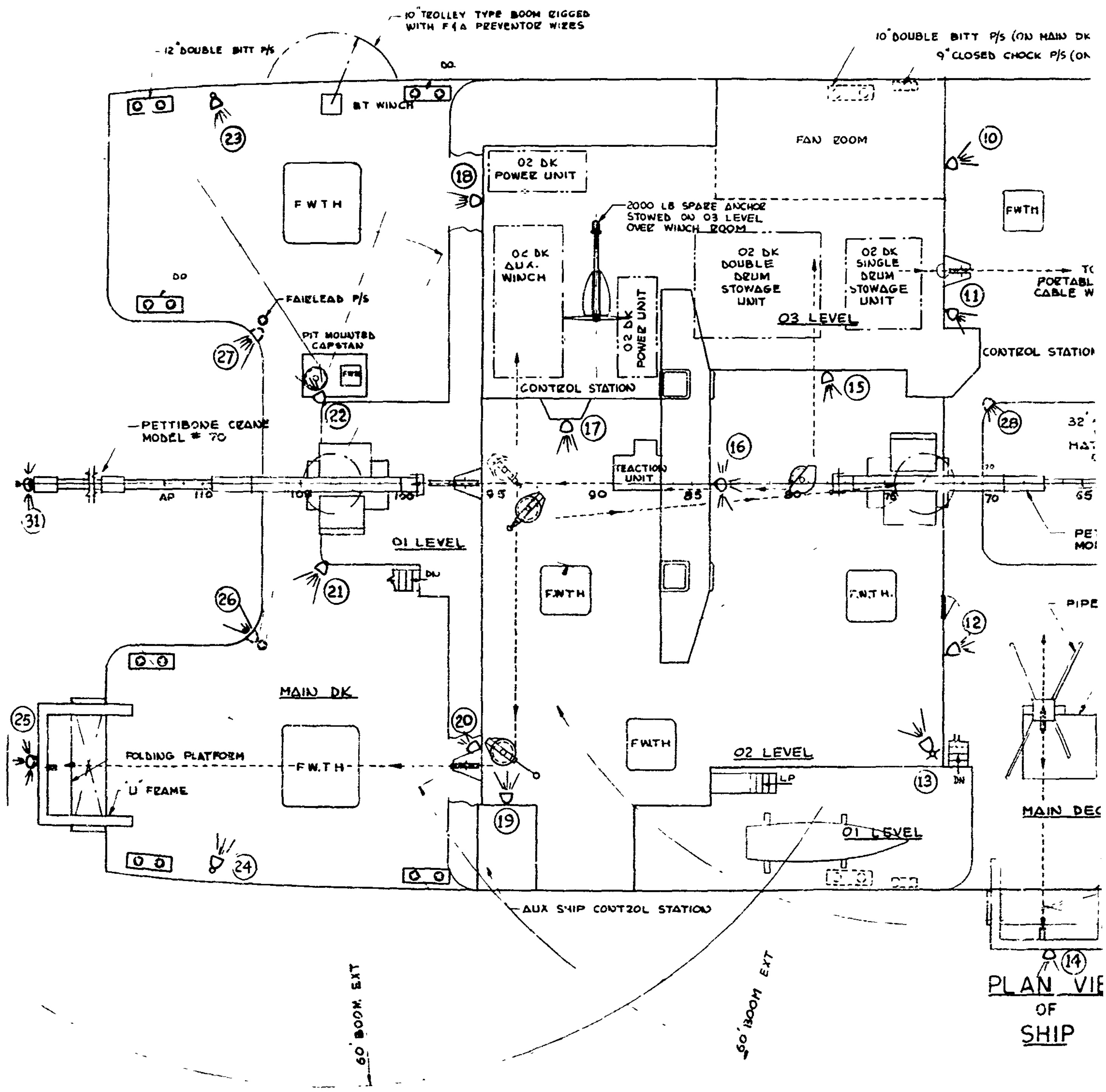
Fig. 64 - Scientific Data Distribution System

A



GEND	CABLES TYPE RECOMMENDED
1 3 MASTER SIGNAL DISTR. PANEL	
——— " " " " (RF SECTION)	BALDEN 8214
.... " " " " (PATCHBOARD SECTION)	TT 26A 6
——— " " " " (VIDEO SECTION)	BIW TV33N

B



10" TROLLEY TYPE BOOM RIGGED WITH F & A PREVENTOR WIRES
12" DOUBLE BITT P/S
10" DOUBLE BITT P/S (ON MAIN DK
9" CLOSED CHOCK P/S (ON
BT WINCH
FAN ROOM
02 DK POWER UNIT
FWTH
2000 LB SPARE ANCHOR STOWED ON 03 LEVEL OVER WINCH ROOM
02 DK AUX. WINCH
02 DK POWER UNIT
02 DK DOUBLE DRUM STOWAGE UNIT
02 DK SINGLE DRUM STOWAGE UNIT
03 LEVEL
PORTABL CABLE W
FAIRLEAD P/S
PIT MOUNTED CAPSTAN
CONTROL STATION
PETTIBONE CRANE MODEL # 70
REACTION UNIT
01 LEVEL
MAIN DK
FOLDING PLATFORM
'U' FRAME
02 LEVEL
01 LEVEL
AUX SHIP CONTROL STATION
60' BOOM EXT
60' BOOM EXT
MAIN DEC
PLAN VIE OF SHIP

A

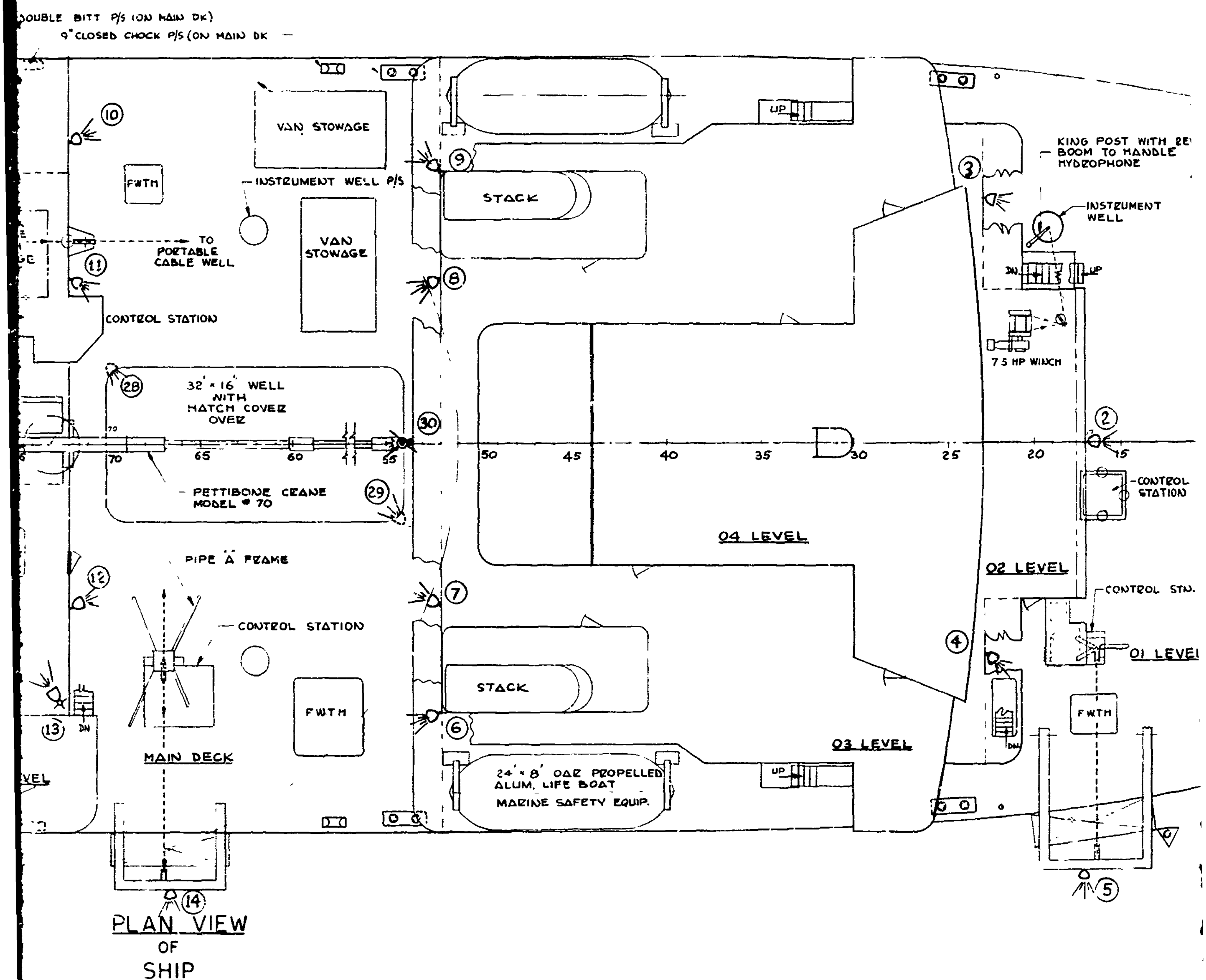

DOUBLE BITT P/S (ON MAIN DK)
9" CLOSED CHOCK P/S (ON MAIN DK
VAN STOWAGE
FWTH
INSTRUMENT WELL P/S
VAN STOWAGE
TO PORTABLE CABLE WELL
CONTROL STATION
32' × 16' WELL WITH HATCH COVER OVER
PETTIBONE CRANE MODEL # 70
PIPE "A" FRAME
CONTROL STATION
FWTH
MAIN DECK
STACK
STACK
24' × 8' OAR PROPELLED ALUM. LIFE BOAT
MARINE SAFETY EQUIP.
04 LEVEL
03 LEVEL
02 LEVEL
01 LEVEL
KING POST WITH BOOM TO HANDLE HYDROPHONE
INSTRUMENT WELL
7.5 HP WINCH
CONTROL STATION
CONTROL STN.
FWTH
UP
DN
70
65
60
55
50
45
40
35
30
25
20
15
PLAN VIEW OF SHIP

Fig. 6

B

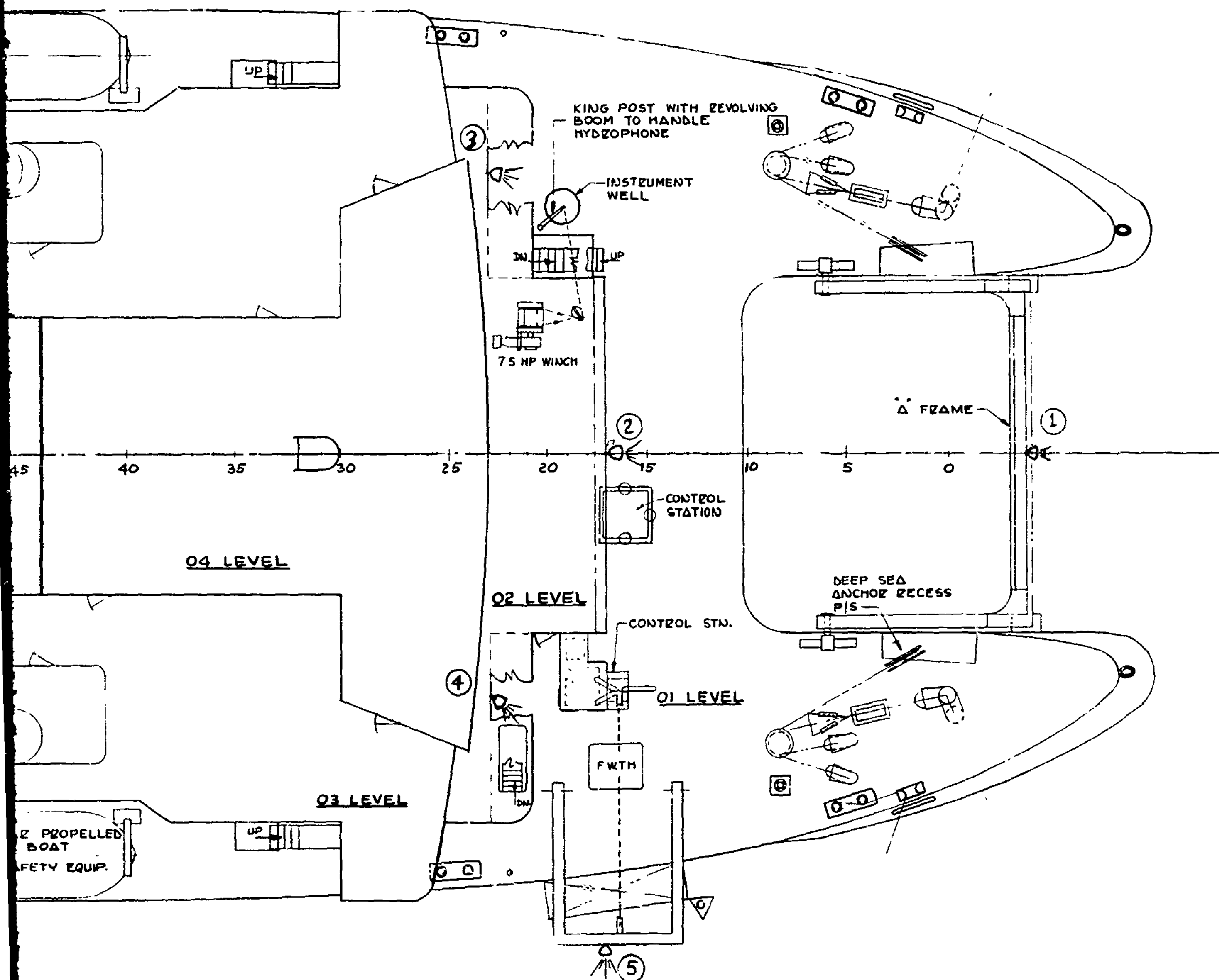


Fig. 65 - Open Deck Lighting System Plan View

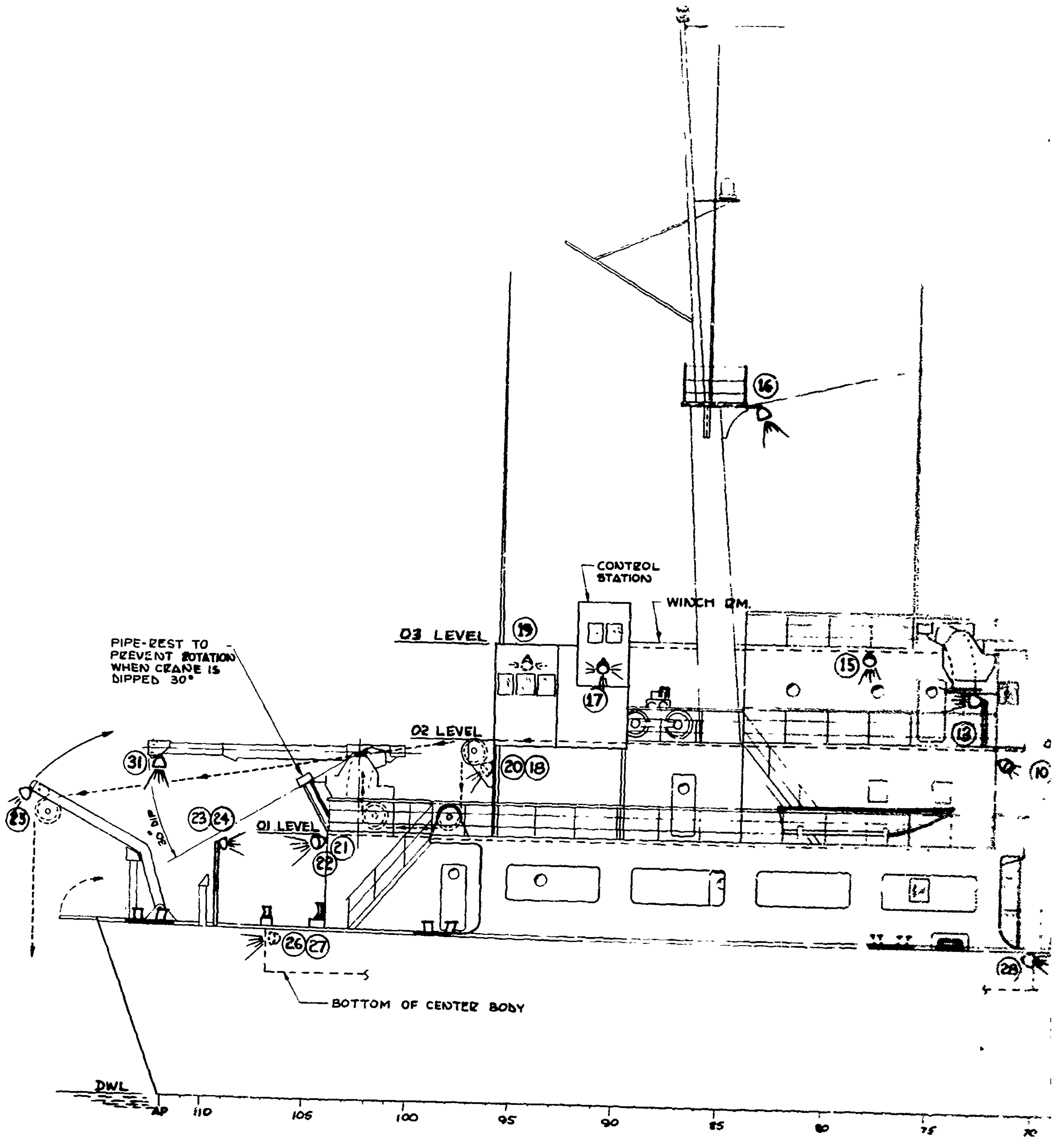
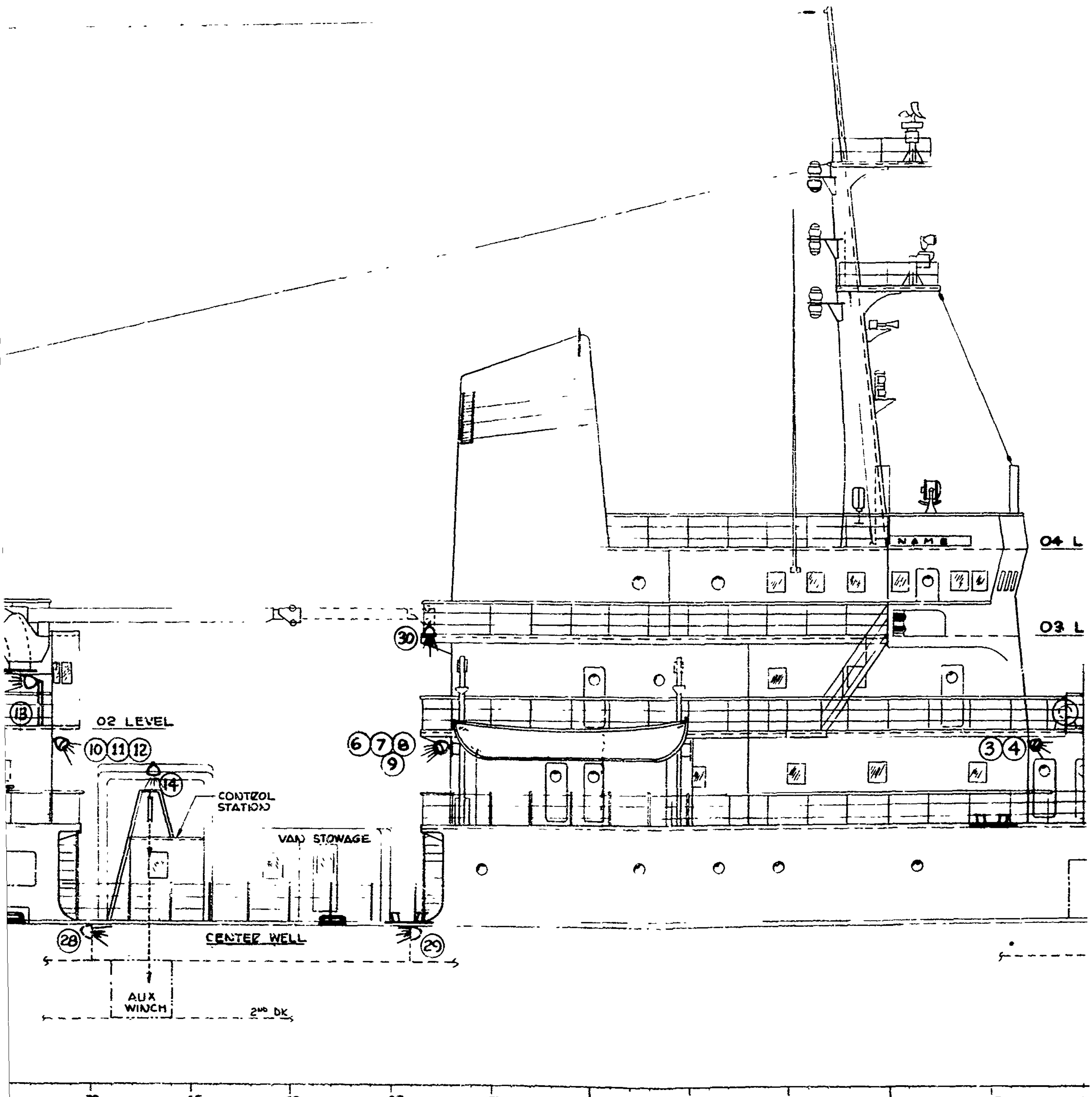
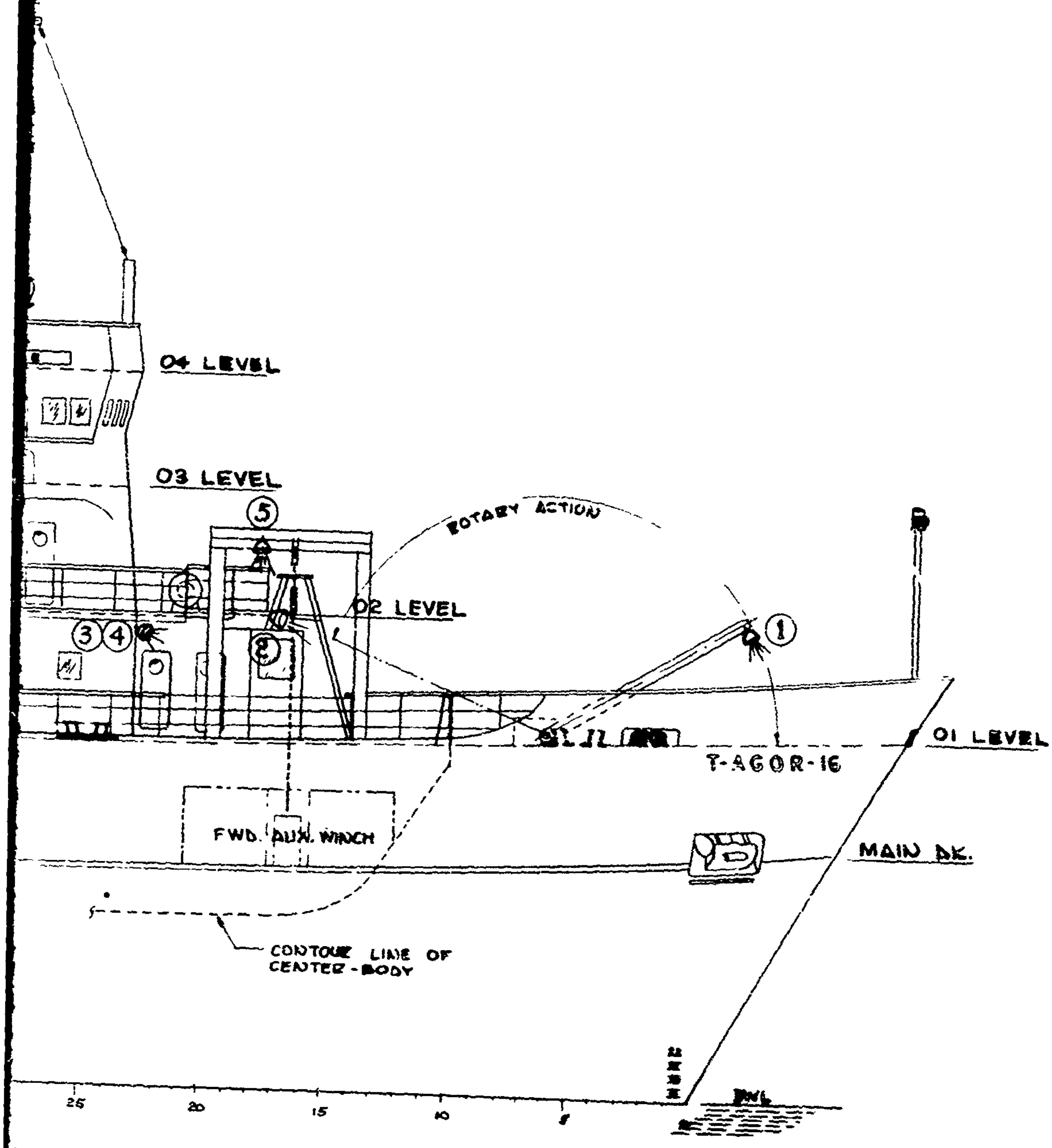


Fig. 66 - Open Deck Lighting System Profile View



OUTBOARD PROFILE

B



04 LEVEL
03 LEVEL
ROTARY ACTION
02 LEVEL
01 LEVEL
T-AGOR-16
FWD. AUX. WINCH
MAIN DK.
CONTOUR LINE OF
CENTER-BODY
DWL
25
20
15
10
5

Internal illumination has been discussed in great detail in the ship's specifications and will not be rediscussed in this report. A photometric survey of the illumination values in the various compartments has been specified prior to acceptance.

XI CONCLUSIONS AND MISCELLANEOUS PROBLEM AREAS

The total cost of equipment including handling gear, cables and electronic suite, without provision for increase of cost due to inflation, was estimated as \$1,295,075 as of September 1968. Spare parts and installation was estimated as \$486,600. Total equipment cost to be budgeted from operating funds (as distinguished from ship construction funds) was \$1,781,675. In addition, certain equipment was designated as being government furnished.

The following list itemizes the user's responsibility for provision of equipment:

ITEM	DESCRIPTION	QUANTITY	LOCATION
1	Rack, standard, 22 in. long x 22 in. wide x 72 in. high, with tie downs (Prem-O-Rack, FA Ser 114-A)	40	Electronics Laboratory
2	Same as Item 1	44	Main Recording Laboratory
3	Pressure tank (16 in. shell)	1	Mechanical Engineering Calibration and Test Laboratory
4	Shell head	1	Mechanical Engineering Calibration and Test Laboratory
5	Gage for pressure tank	1	Mechanical Engineering Calibration and Test Laboratory
6	Hydrophone calibrator	1	Mechanical Engineering Calibration and Test Laboratory
7	Pressure tank pump	1	Mechanical Engineering Calibration and Test Laboratory
8	High pressure panel, 3000 psi	1	Mechanical Engineering Calibration and Test Laboratory

ITEM	DESCRIPTION	QUANTITY	LOCATION
9	Hydrophone storage rack	1	Mechanical Engineering Calibration and Test Laboratory
10	Freon tanks	2	Mechanical Engineering Calibration and Test Laboratory
11	Freon detector	1	Mechanical Engineering Calibration and Test Laboratory
12	Dead weight tester	1	Mechanical Engineering Calibration and Test Laboratory
13	Vacuum pump and tank	1	Mechanical Engineering Shop
14	Curing oven for potting	1	Mechanical Engineering Shop
15	Hydrophone, 3 crystal	1	Sonar Dome
16	Printer	1	Computer Room
17	Card reader punch	1	Computer Room
18	Console	1	Computer Room
19	Analog Inputs	1	Computer Room
20	Processor controller	1	Computer Room
21	Digital Input Terminals	1	Computer Room
22	Tape	1	Computer Room
23	Tape	1	Computer Room
24	System stowage	1	Computer Room
25	Disk stowage	1	Computer Room
26	Accessory driver	1	Research Control Center
27	Navigation Electronics Racks, 22 in. x 22 in.	2	Research Control Center
28	Acoustic Position Determining System	1	Research Control Center
29	Filters, Type V	as req.	Scientific Radio Room

Many of the items on the preceding list do not have to be supplied to the building yard since they can be readily installed at a later date.

The authors have always felt that the U-frames and platforms should have been covered by the ship construction funds in order to eliminate an interface problem. They are not catalog items and are intimately associated with the ship's structure. Moreover, their construction is well within the capability of a shipyard.

The problem of the unavailability of timely funding for equipment has already been discussed. Retrofitting of equipment is always costly, particularly when heavy handling gear is concerned. Since the state of the art of electronic equipment is subject to rapid advancement, late procurement of this equipment may represent an advantage since the ship construction period is so lengthy. When outfitting time drags on, however, the danger always exists that costs escalate and funding dries up.

The authors feel very strongly that an electrician will be required aboard the ship. This recommendation was made on a number of occasions. At one time, an unassigned room was to be configured for occupation by an additional CPO, but a review of the latest plan indicates that this room is to provide additional crew's berthing.

Since funding was a major problem and actual ship construction costs were exceeding estimates, the suggestion was made to reduce the beam of the catamaran to allow for its passage through the St. Lawrence Seaway. This had the effect of opening bidding to Great Lakes shipyards, thereby increasing competition and reducing tonnage and direct costs slightly.

The beam had to be reduced from 80 to 75 ft with a minimum effect on laboratory layout. This was accomplished by reducing the after deckhouse weather passages by 1 1/2 ft each and reducing the distance between the hulls by 2 ft. The inboard bulkheads of each hull were notched and a minor reduction in width of fore-aft hull passageways to accommodate the structure resulted. The laboratories below the main deck were unaffected. The stiffeners of the fore-aft bulkheads bounding the recording and electronics laboratories and mechanical engineering shop were moved outboard of these spaces. This almost compensated for the 2-ft reduction in width of the compartments and interior layouts were not materially affected. The laboratories over the hulls were reduced slightly in width which represented only minor inconvenience except in the wet laboratory. In this particular area, the entire arrangement was revised to incorporate new suggestions by the scientific users.

On April 1, 1968, the announcement was made that Hudson Laboratories was to be closed and that the catamaran would be turned over to the Naval Research Laboratories. On May 20, 1968, the authors made a formal presentation to NRL on the subject vessel, and since that time, they have only been involved on a consulting basis.

A bidders conference was held on September 5, 1968 and a contract was awarded to Todd Shipyards, Seattle, Washington in December 1968 for $13,950,000. Total cost equipped will be in the order of $16,000,000.

We had recommended that arrangements be made for the ship to run the AUTEC range during the acceptance trials since this appears to be the only reasonable method for checking on the acoustic requirements of the specifications.

We had requested that MSTS provide a shipyard representative during the construction period, preferring to concentrate our own effort on problems relating to the scientific mission, but this was not possible due to a lack of personnel. Hudson finally agreed to supply a yard representative who would represent Hudson, ONR, the Program Manager's Office and who would look after MSTS interests and supervise a design agent to be retained by ONR.

ACKNOWLEDGMENTS

Mr. Rolf Andersen, formerly of Hudson Laboratories and now at the Naval Research Laboratories, concerned himself with the electrical and electronic problems, equipment and layout of electronic laboratories. Had he remained at Hudson, he would have been a co-author of this report.

Many other members of the engineering and scientific staff at Hudson contributed to the development of the layouts and equipment specifications. A partial list follows:

Handling Gear and Mechanical Engineering Spaces	T. Kelly E. O'Neill P. Weber
Electronic Equipment and Layout	I. Weisman D. Vigliotti
Scientific Areas	T. Pochapsky
All Layouts and Design Sketches	H. Greene J. Taylor

The Naval Ships System Command performed all preliminary design studies and wrote the ship specifications. The following individuals were most helpful in guiding our progress:

R. Comley	H. Meier
O. Hendel	O. Pannel
W. Holtgren	R. Venable
J. Kleinheinz	

LCDR. David Tinkler of the Office of Naval Research, LCDR. Arnold of COMSTS, and Mr. Stuart Nelson of the Naval Oceanographic Office were most helpful to the authors.

Mr. F. Serim and Mr. M. Feintuch of M. Rosenblatt & Sons were extremely cooperative and were willing to deviate from tradition in order to enhance the oceanographic mission of the ship.

We are grateful for the guidance supplied by Mr. G. Jayne and Mr. M. Silverman of the Instrumentation Ships Project Offices (PMS-5).

A debt of gratitude is owed to Mrs. Edith Wergen and Miss Elizabeth Migliore for their assistance in the preparation of this and many other reports.

APPENDIX A

PRELIMINARY EQUIPMENT AND FACILITIES
LIST USS TERROR MMF-5 CONVERSION TO
AN OCEANOGRAPHIC RESEARCH VESSEL

1 DECK HANDLING GEAR

A. Forward

1. Forward, 3 drum Western Gear type traction winch scored with 1 1/4 in. grooves, capable of storing 38,000 ft of 3/4 in. wire rope per drum. 45,000 - 50,000 maximum pull, (150-200 hp). Shafts to be equipped with slip rings.
2. U-frame on bow to service (1) above.
3. Windlass, chain, anchor and stowage for chain (locker) for deep sea anchoring. Anchor and chain size to be determined. Overboard stowage of anchor.
4. Small crane forward - 1 ton at 30 ft reach.
5. One hydraulically operated dual drum auxiliary winch with hydraulic back tensioning and continuously variable level wind. Both drums equipped with slip rings and capable of holding 20,000 ft of 1/2 in. wire rope. 10,000 lb pull at 150 fpm, 5000 lb at 300 fpm. Winch covered by deckhouse.
6. Motorized trolley boom to service above winch.

B. Stern

1. 3-drum Western Gear type traction winch grooved for 1 1/4 in. capable of stowing 38,000 ft of 3/4 in. wire rope per drum each with its own continuously variable level wind. All shafts equipped with slip rings. Maximum pull 45,000 lb to 50,000 lb, (150 - 200 hp).
2. Two hydraulically operated dual drum auxiliary winches with hydraulic back tensioning and continuously variable level winds. Both drums equipped with slip rings and capable of holding 20,000 ft of 1/2 in. wire rope. 10,000 lb pull at 150 fpm, 5000 lb at 300 fpm. One winch to serve one side; the other the stern.
3. Motorized trolley boom to service side launching.
4. Overhead traveling crane 25-ton capacity with provision for overboarding gear at stern.

C. Mid-Ships

1. Dual drum hydro winch, integral power pack, high speed, 30,000 ft 5/32 in. wire rope.
2. Dual drum instrumentation winch, high speed equipped with slip rings. Cable size and speed under investigation.
3. Motorized trolley booms to service above winches.
4. BT winch and boom.
5. 30,000 lb boom (existing).
6. Two towing booms, length and load to be determined -- one each side.

II OTHER FEATURES (MECHANICAL)

1. Large Bos'n Lockers forward and aft for scientists' rigging, bins, shelves, etc.
2. Port and starboard cap and booster ready service lockers; fore and aft.
3. Two prefabricated "On Deck" magazines for explosives per Coast Guard 108. 1/8 in. plate, wood lined vented, wood skids, shielding, non-spark interior, etc., 300 ft^3 capacity each.
4. Built in hydraulic oil stowage tank.
5. Additional sea chest for lab., gear, winches, air conditioners, amplifiers, etc., as required.
6. Plug in welding outlets on main and lab. decks and two portable machines.
7. Large hatches to service lab. and stowage areas.
8. Elevators - internal deck to deck equipment exchange (existing).
9. Lab. monorail system.
10. Machine shop - lathe, miller, drill, doall saw, grinder, cut-off saw near structural steel stowage.
11. Three hydrophone wells (36 in. dia.) with hoists for future installation of acoustic tracking system.
12. Two day rooms, one on second deck with refrigerator, hot plate, silex, and water cooler, etc.; the other below with easy chairs, tables, etc.

13. Library.

14. Head for laboratory area.

15. Footage counters on all winch drums with output at controls with line speed indicators and tensiometers.

16. Plentiful deck lighting; specifically in handling area.

17. Sufficient potable water for silent ship use and anchoring.

18. Cut-back main deck at stern and open one side forward of cut-back.

19. On deck gasoline stowage racks for approx. 500 gallons.

20. A 26 ft workboat and small aluminum boat with outboard motor.

21. Provision for launching and retrieving deep submersible vehicle.

III RADIO ROOM (SCIENTISTS)

1. Two single side band, 1 kw output, 6 channels each with A.M. capability.
2. FM transceivers - 4 channels.
3. Rotating UHF, VHF and FM dipole antennas.
4. Two 1/2 wave long wire antennas.
5. Four 1/4 wave stainless whips.
6. Terminal boxes for antenna couplers.
7. Precision time keeping electronics including VLF receiver.
8. Communication receivers for SSB and AM.
9. Special purpose receivers.

IV ELECTRICAL

1. Signal cable distribution - winch slip rings to labs.
2. Power intercom system - lab. and handling areas.
3. PA system.
4. Power regulation 60 cps and 400 cps.
5. Power outlets at handling gear and portable van areas.
6. Power amplifiers, sizes to be determined.

V SCIENTIFIC NAVIGATIONAL EQUIPMENT

1. High resolution radar.
2. Loran "A" and "C".
3. Decca with readout.
4. Omega navigation.
5. Satellite navigation.
6. Tank mounted hydrophone.
7. UQC, DRT, pit log, RBF, PDR
   Fathometer (different frequency than ship's), repeaters of ship's tachometer, rudder angle, gyro and wind. Anchor tension recorder.
8. Remote units of scientist communication equipment, chart files, and plotting tables.

APPENDIX B

HUDSON LABORATORIES RECOMMENDATIONS FOR MECHANICAL HANDLING GEAR, ELECTRONIC, NAVIGATION, COMMUNICATIONS EQUIPMENT AND POWER REQUIREMENTS FOR PROPOSED 306-FT LONG, 3200-TON AGOR

A. Forward Section of Ship

1. One traction type winch grooved for 1 1/4 in. diameter cable with 30 in. root diameter of traction sheaves minimum. To be provided with three stowage drums, each capable of storing 38,000 ft of 3/4 in. diameter wire rope. 50,000 lb maximum pull at 100 FPM, 15,000 lb pull at 330 FPM. Shafts of each stowage drum to be equipped with slip rings. One drum to be provided empty. Each of the other drums to be provided with 38,000 ft of 3/4 in. diameter, 3 x 19 extra improved plow steel, torque balanced, elevated elastic limit wire rope to be provided in continuous lengths with no splicing.

2. Hydraulically operated U-frame on bow to service (1) above. To be rated for 50,000 lb pull in any direction against outboard stop and capable of swinging out a 15,000 lb load. 90° swing required. U-frame should be 8 ft wide by 12 ft high, clear inside.

3. A handling facility should be provided for handling a 1000-lb anchor and 2000 lb of chain to be attached to the bitter end of the anchoring rope.

4. One hydraulically operated dual drum auxiliary winch with hydraulic back tensioning and continuously variable level wind. Winch drums to be located 90° to one another--one servicing the bow and one the starboard side. Each drum to be equipped with slip rings and capable of storing 20,000 ft of 1/2 in. diameter wire rope. Winch to be rated at 20,000 lb pull at 150 FPM, 5000 lb at 300 FPM. Drum servicing the bow to be equipped with 20,000 ft of 1/2 in. diameter wire rope 3 x 19 construction same basic specifications as in (1) above. The drum servicing the starboard side should be equipped with 20,000 ft of four conductor double armored cable.

5. Hydraulically operated U-frame to service the starboard facing drum of above winch with platform. This U-frame to be capable of handling a 20,000-lb load in any direction when against the outboard stops. Should be capable of transiting a 10,000-lb load. U-frame same dimensions as (2) above.

6. Rotatable telescoping boom rated at 6400 lb at 35 ft maximum reach to service both forward and starboard U-frames.

7. Provision for storing two deep sea anchors outboard at the bow (in addition to the standard ships anchors).

B. Stern Area

1. One traction winch identical to that specified for the bow to service the stern of the ship. One drum to be provided empty and each of the other drums to be provided with 20,000 ft of approximately one inch diameter armored electrical cable for source work. It is hoped that with minor adaptations, this winch can also be used as part of the system for handling cable from a well. This must be investigated further.

2. One hydraulically operated dual drum auxiliary winch identical to that specified for the bow. In this case, one drum to service the stern and one drum for the starboard side. The drum servicing the side should be provided with 20,000 ft of four conductor armored cable and the drum servicing the stern should be equipped with 5000 ft of one inch diameter armored electrical cable. Stern overboarding sheave capable of passing large tow chain should be provided along with several 100-ft lengths of chain.
3. Hydraulically operated U-frame and platform on starboard side identical to starboard U-frame for bow area.
4. Overhead traveling crane. 25-ton capacity with provisions for overboarding gear at the stern and transferring loads. Hook clearance and width to be determined after inspection of general ship's plan. We want generous stern clearance for handling of DRV and large sources.
5. BT winch and rope.
6. One portable instrument chain winch system with associated instrumentation and recording facility.

C. Midships Equipment

1. 15-ton ship's crane (not a boom) to service stern and midship areas with 15 ft reach over the starboard side. This should be considered a piece of ship's equipment rather than scientific equipment, but is required by us regularly for loading and occasional handling of gear over the side.

2. One dual drum hydraulically operated auxiliary winch, identical in all respects with the auxiliary winches specified for the bow and the stern except for arrangement. In this case, each drum will service the starboard side. This winch should be placed adjacent to the wet lab, and will serve as both an auxiliary winch and a hydrographic winch. One drum should be provided with a removable barrel for providing a larger diameter for hydrographic wire in order to obtain high line speed. This drum should be equipped with 30,000 ft of 7 x 7 galvanized hydro wire, 3/16 in. diameter. The other drum should be equipped with 20,000 ft of four conductor armored cable.

3. One hydraulically operated U-frame to service the starboard side and the above winch. A platform should also be provided. The ratings of this U-frame should be identical to the other two starboard U-frames.

D. Other Handling Equipment

1. We would like a cable well which might be convertible to a stowage compartment or vice-versa. The location of this well will, of course, be determined by the general ship layout. It can be either forward or aft. Its capacity should be approximately 30 miles of one inch diameter cable. One of the existing traction winches could possibly be adapted to handle this cable over the side. A braking system for positive control of the cable would be required in addition to the winch.

E. General Comments

1. Where possible, winches and stowage drums should be placed under cover to protect the equipment and to afford shelter to the operator.

2. All winches should be equipped with tensiometers, line speed indicators and footage counters. Provisions should be made for recording anchoring tensions, wind direction, wind velocity and ship's orientation whether anchoring from the bow or the stern.

COMMUNICATIONS:

External

Antennas -

(a) Suitable areas to be provided for two 35-ft Vertical Antennas for use of scientific party.

(b) Suitable area to be provided for one 30-40 MC whip antenna.

(c) Provisions shall be made for suitable antenna sites for Navigational Antennas such as Loran C, Omega, Decca and Raydist.

(d) A platform to be provided for additional experimental and special purpose antenna with access trunk to main scientist navigational laboratory.

Radio Facility -

A separate transmit-receive facility is requested for use of scientific party, consisting of the following:

(a) 2 AM/SSB transceivers, 1 KW, 500 watts capable of continuous duty -- frequencies 2-30 MC A3, A3J, A9B.

(b) 1 FM transceiver, dual channel, 30-40 MC range.

(c) 2 Hi-quality communication receivers.

(d) RTTY equipment.

Remotes shall be provided in -- (1) Navigation Laboratory

(2) Laboratory Nos. 1 and 2

Internal

There shall be two separate intercom systems:

(a) General intercom (telephone type) with optional loudspeakers where required MIL-T-1943-B (ships) capable of 20 simultaneous circuits.

(b) High power intercom linking control stations, laboratory and launch sites -- all stations talk to all stations, noise cancelling features incorporated.

Signal Data Cable -

Suitable low noise cable shall be installed between various winch locations and signal termination panels in three laboratory areas and computer room.

High current cables shall be interconnected between the laboratory areas and launching sites.

LABORATORIES:

Main scientist Navigational Laboratory (adjacent to or part of main Electronic Laboratory)

Equipment List -

(1) Narrow beam fathometer system with bottom tracker type recorder and Precision Recorder of the Dry Paper type (Raytheon PFR-193).

(2) 1 UQN-1E capable of 12 KC and 34 KC operation with Precision Recorder.

(3) 1 sub-bottom profiling system (sparker) with recorder.

(4) Radar -- Ship basically will have 2 radar systems and it would be desirable to have scientific use of either one of these 2 systems as required simultaneously with bridge -- i.e., radar repeater in laboratory.

(5) Loran C (automatic tracking) or Omega will be required. Choice to be made on basis of state of art, at time of acquisition.

(6) Satellite navigation -- Space provision shall be made for Decca as required.

(7) Gravity room.

(8) Magnetometer.

(9) Combination Loran A and C should be part of ship's equipment.

(10) A time code generator shall be provided with suitable BCD outputs for both graphic and digital recording remote visual readouts shall be provided on the bridge and each laboratory site.

(11) A repeater section shall be provided for ship's speed, heading, wind velocity, wind direction (etc.). Outputs shall be available in DC form compatible for recording in analog or digital form. This shall be distributed to other laboratory areas. Anchoring tension shall also be available.

(12) Underwater telephone system will be required.

(13) Amplifier room:

One 15 KW Power Amplifier

One 10 KW Power Amplifier

Two 1 KW Power Amplifiers

(14) Hull-mounted hydrophones in underwater pods for recording shot instants.

POWER REQUIREMENTS:

Main generator for scientific facility should have a capacity of about 300 KW.

10 KW	Computer laboratory
25 KW	Electronics laboratory No. 1
25 KW	Electronics laboratory No. 2
120 V	60 cps, both regulated and unregulated, should be included in each laboratory space.
10 KW	At 440 cps.
440 V	3-phase and 208 V should be available to supply power amplifiers.
1 KW	At a precision 60 cps frequency is necessary for accurate speed control of tape recorders and associated equipment.

APPENDIX C

PRELIMINARY CHARACTERISTICS FOR OCEANOGRAPHIC RESEARCH SHIP CATAMARAN HULL

1. General Discussion of Design

(a) In designing the machinery installations, particular attention shall be paid to the use of acoustic silencing techniques to obtain the lowest possible ships radiated noise level while maintaining steerageway without the use of diesel main propulsion plant.

(b) The ship, its machinery and outfitting shall meet the requirements of the American Bureau of Shipping, MSTS, the United States Coast Guard, the U. S. Public Health Service and the Federal Communications commission.

(c) Provision shall be made for minimum operational crew and minimum maintenance. Automated features shall be incorporated to the maximum extent practicable.

2. Hull Characteristics

(a) Approximate dimensions and displacement:

(1) Length between perpendiculars - 210 feet

(2) Beam, maximum - 86 feet

Each hull 26 feet

Distance between hulls 34 feet

(3) Draft - 19 feet

(4) Displacement, full load - 3200 tons

(b) Subdivision: A two compartment standard is required (Note 1).

(c) Seaworthiness and maneuverability: A high degree of directional control, maneuverability and optimum seakeeping qualities at very low speeds are desired.

(d) Damage control: Damage control features in accordance with United States Coast Guard and MSTS Class II requirements.

(e) Class C ice-strengthening in accordance with American Bureau of Shipping regulations.

(f) A future growth margin of 50 tons at the main deck level shall be provided.

(g) The trailing edge of the rudder shall be located at least 10 feet forward of the stern.

3. Special Features

(a) The following facilities shall be provided:

(1) Oceanographic laboratories consisting of "wet" and "dry" laboratories on the main deck adequate for the collection and immediate processing of oceanographic samples and data.

(2) Navigational control center adequate for the installation and operation of oceanographic sensors and recorders, and the immediate recording and plotting of oceanographic data.

(3) An electronic recorder room for the centralized recording of data sensors.

(4) Photographic processing facilities.

(5) Calibration and instrument test facilities.

(6) Scientific office space or library.

(7) Scientific chill and freeze rooms of approximately 500 cubic feet. Chill room convertible to freeze.

(8) Gravity meter room.

(b) Scientific stowage space for scientific equipments and supplies and oceanographic samples.

(c) Stowage designed for approximately 20 tons of explosives to meet U. S. Coast Guard regulations with topside stowage for approximately 300 cubic feet.

(d) Winches, articulated cranes, davits and "U" frame for scientific use.

4. Armament

None

5. Communications and Electronics

(a) Communications and electronics equipment shall be provided to meet the requirements of the Electronics Requirements Plan.

(b) Naval Electronics Systems Command shall submit an Electronics Equipment List for approval by the Chief of Naval Operations.

(c) Standard visual signal facilities including two high performance signal lights shall be provided.

6. Propulsion and Engineering Features

(a) Speed: Sustained speed of 16 knots.

(b) Endurance: 6500 miles at 16 knots.

(c) Power plant: Twin screw propulsion plant with bridge control shall be provided.

(d) Auxiliary propulsion equipment shall be provided to satisfy the requirement for quiet operations while maintaining steerageway.

(e) Electrical plant:

(1) Ship's service: The ship's service generators shall be multiple units of sufficient capacity so that in the event of derangement of one unit, the remaining units can carry the normal operating load.

(2) A separate generator and distribution system for scientific instrumentation.

(f) Distilling plant: Evaporators shall be provided in multiple units with sufficient capacity to provide 60 gallons per man per day in accordance with the accommodations listed in paragraph 10, plus that required for hydrographic and oceanographic use.

(g) Potable water stowage: Stowage shall be provided for not less than 120 gallons per man for the accommodations listed in paragraph 10, plus 1000 gallons of water for scientific use.

7. Protection

None

8. Aviation Features

None

9. Command and Ship Control

(a) Bridge:

(1) A Navigational Bridge and Pilot House with bridge wings extending the width of the ship with automatic course control equipment.

(b) A Chart House located on the same level and aft the bridge.

(c) An Auxiliary Control Station located aft.

10. Accommodations, Berthing, Messing and Sanitation

(a) Accommodations:

	OFF	CIV TECH	CPO	OTHER ENL	TOTAL ENL
Crew (Civilian)	16		5	37	42
Scientific personnel		30			
Total	16	30	5	37	42

(b) Messing: Two messes shall be provided in accordance with usual practice on civilian manned ships.

(c) Sanitation: Sanitation facilities in accordance with standard regulations of the U. S. Public Health Service and U. S. Coast Guard.

(d) Air conditioning: The living, messing, laboratory and office spaces shall be air conditioned.

(e) Merchant Marine habitability standards in accordance with usual practice on civilian manned ships.

(f) Sewage retention and treatment tanks shall be provided. All overboard discharges, where feasible, shall be outboard.

11. Provisions and Stores

(a) Stowage space for consumable stores based on the total accommodations shown above shall be provided as follows:

	Days Endurance
Dry provisions*	90
Frozen provisions*	90
Chilled provisions*	45
General stores material	60
Medical stores	120

*This requires that stowage space for 90 days subsistence endurance without replenishment shall be provided including refrigerated facilities for a minimum stowage capacity as indicated. Chill stowage shall be convertible to frozen. Separate boxes for freeze ($0^{\circ}F$), chill ($35^{\circ}F$), dairy ($32^{\circ}F$), fish ($0^{\circ}F$) and thaw (38° - $40^{\circ}F$).

(b) Separate stowage space shall be provided for deck, engine and steward stores in accordance with MSTS practice.

12. <u>Miscellaneous</u>

The following shall be provided:

(a) Stowage for boats of the following types:

2 - 24-foot U. S. Coast Guard approved Class I life boats stowed in davits.

2 - 16-foot Boston whaler workboats with outboard motors.

(b) A capability of towing and being towed. A towing machine is not required.

(c) A bonded stores locker and small arms locker.

(d) Shops for routine maintenance.

(e) A capability of deep anchoring by the bow and stern.

(f) Degaussing is not required.

(g) A limited Scuba diving capability.

(h) Open deck space for two instrument vans or huts.

(i) Three sea chests in the hull for affixing electronic devices.

(j) Air stowage flasks for 300 cubic feet of free air.

(k) General intercommunications dial telephone type of at least 20 simultaneous circuits.

(l) High volume electronic intercommunications systems.

(m) Sonar amplifier room.

Note 1: Deviation from the two compartment standard is authorized in engineering and laboratory spaces as required to meet reduced manning requirements and for ease of mission accomplishment.

ELECTRONICS REQUIREMENT PLAN

1. <u>Infrared Communication Facilities</u>

   None

2. <u>Radio Transmitting Facilities</u> (See Note 1)

   (a) 1 - 405-525 kcs; A1, A2

   (b) 1 - 2-24 mcs; A1

   (c) 1 - 2-9 mcs; A3

   (d) 3 - 2-30 mcs; A1, A3, A3J, A9B, F1; 100 miles gapless (2-6 mcs)

   (e) 1 - 405-525 kcs; A2; battery powered

   (f) 1 - 156-162 mcs; F3

   (g) 1 - 200-400 mcs; A3

   (h) 1 - 30-40 mcs; F3

3. <u>Radio Receiving Facilities</u> (See Note 1)

   (a) 1 - 100-535 kcs; A1, A2

   (b) 1 - 2-24 mcs; A1

   (c) 1 - 2-9 mcs; A3 (included in 2(c) above)

   (d) 5 - 2-30 mcs; A1, A3, A3J, A9B, F1 (3 included in 2(d) above)

   (e) 1 - 350-535 kcs; A1, A2

   (f) 1 - 2-24 mcs; A1, A3, F4

   (g) 1 - 156-162 mcs; F3 (included in 2(f) above)

   (h) 1 - 200-400 mcs; A3 (included in 2(g) above)

   (i) 1 - 30-40 mcs; F4 (included in 2(h) above)

4. Terminal Facilities

(a) 1 - Simplex FSK teletype facility with teletype tape facility plus one modulated TTY converter

(b) 1 - Facsimile 60/90/120 LPM full duplex

5. Radar Facilities (Note 1)

(a) 1 - 10 CM "main" navigational radar

(b) 1 - 3 CM navigational radar

6. Sonar Facilities (Note 1)

(a) 1 - Echo sounders deep

(b) 2 - Precision Depth recorders (Dry paper)

(c) 1 - Echo sounder, shallow with recorders

**(d) 1 - Echo sounder, deep, narrow beam, electronically stabilized

(e) 1 - Echo sounder deep, 12 kc and 34 kc

(f) 1 - Underwater telephone with dome

7. Countermeasures Facilities

None

8. Navigational Facilities (Note 1)

(a) 1 - Omega

(b) 1 - Loran "C" receiver

(c) 1 - Radio Direction Finder (210-520 kcs)

(d) 1 - Mark 19 Gyro

(e) 1 - Satellite Receiver

9. Radiac Facilities

None

10. Remote Station Facilities

(a) Pilot House

1 - Control and monitoring of 2 voice channels

1 - Radar display/control 10 CM

1 - Radar display/control 3 CM

(b) Chart House

1 - Reception of CW channel

1 - Control of radio direction finder

1 - Control of echo sounder, shallow

1 - Control of Omega

(c) Navigation Control Center

1 - Control of CW/voice channel

1 - Radar display 3 CM

1 - Control of Loran "C"

1 - Control of echo sounder, deep

1 - Control of echo sounder, deep, narrow beam, electronically stabilized

1 - Control of underwater telephone

1 - Control of satellite receiver

(d) Radio Room

1 - Control and monitoring of all ship voice/CW channels

11. Meteorological Facilities

None

12. Supplementary Radio Facilities

None

13. Special Facilities (See Note 1)

(a) 1 - Automatic alarm

(b) 1 - Automatic alarm keyer

(c) 3 - Remote scientific transceiver stations

(d) 1 - Time code generator

*(e) 1 - Sub-bottom profiler system with recorder

Note 1: NAVSHIPSYSCOM approved commercial marine equipment shall be utilized to fulfill these requirements, wherever possible.

Note 2: Items marked with (*) are not service approved. Installation shall be accomplished subsequent to equipment identification.

APPENDIX D

PRELIMINARY LIST OF HANDLING GEAR
CATAMARAN

A. Forward Section of Ship -- Based Upon Decking Hulls to 01 Level

1. One traction type winch grooved for 1 1/4 in. diameter cable with 30 in. root diameter of traction sheaves -- minimum. This winch is to be used primarly for bow anchoring. To be provided with three stowage drums -- each capable of storing 38,000 ft of 3/4 in. diameter wire rope. 50,000 lbs maximum pull at 100 ft per minute, 15,000 lbs pull at 330 ft per minute. Shafts of each stowage drum to be equipped with slip rings. One drum to be provided empty, each of the other two drums to be provided with 38,000 ft of 3/4 in. diameter, 3 x 19 extra improved plow steel, torque balanced, elevated elastic limit wire rope to be provided in continuous lengths with no splicing.

The traction unit to be similar to Western Gear Model TUH-150 adapted as noted above. Two of the stowage drums, similar to Western Gear Stowage unit, Model DDS-1, except that we desire an individual level wind for each drum and the drum size should be adapted to the quantity and size of cable specified. The third stowage drum, similar to Western Gear Model SDS-1, with larger drum. The power unit for this winch, similar to Western Gear Model DSPU-150.

We believe this power unit can serve as the prime mover for the auxiliary winch listed in (2) below, thereby reducing the cost of this auxiliary winch.

2. Hydraulically operated dual drum auxiliary winch with hydraulic back tensioning, each drum provided with a continuously variable level wind. Each drum to be equipped with slip rings and capable of storing 20,000 ft of 1/2 in. diameter wire rope. Winch to be rated at 20,000 lbs pull at 200 ft per minute, 5000 lbs at 500 ft per minute. One drum to be equipped with 20,000 ft of 1/2 in. diameter wire rope, 3 x 19 construction, same basic specifications as in (1) above. The other drum should be equipped with 20,000 ft of 4-conductor double armored cable. This winch should be similar to Western Gear Model DSWH-200 without the electric drive motor and pump, but with a second drum.

3. Motorized trolley servicing a 10 ft wide port between main and 01 decks on starboard side extending 10 ft over-the-side for over-boarding equipment to be lowered by winches itemized in (1) and (2) above. Should be capable of transiting a 10,000 lbs load and carrying a 20,000 lbs load in any direction in its outboard position.

4. A structure bridging the two hulls at the bow providing for stowage of two 1000 lb high strength anchors with weighted stocks (3000 lbs total weight of each anchor). Bridge structure to be provided with 30 in. diameter swivel snatch sheave grooved for 3/4 in. wire rope. Structure should be capable of sustaining a minimum 50,000 lb load. A hand crank davit or A-frame for swinging the anchors clear would be required. Bridge structure to be equipped with catwalk for access.

B. Stern Area

1. One winch identical to that specified in item A-1 to service the stern and center well areas of the ship. One drum to be provided empty and each of the other drums to be provided with 20,000 ft of approximately 1 in. diameter armored electrical cable for acoustic source work. Two winch control stands per our drawings.

2. One hydraulically operated dual drum auxiliary winch identical to that specified for the bow area, except in this case, the winch will require an electric motor and hydraulic pump drive. One drum should be provided with 20,000 ft of 4-conductor armored cable and the other with 5000 ft of 1 in. diameter armored electrical cable. A stern overboarding sheave capable of passing large tow chain should be provided and several 100 ft lengths of chain should also be provided A control cab mounted on the main deck with view of second deck drums is essential.

3. Hydraulically operated U-frame and removable platform to service (2) above to be rated for 50,000 lbs pull in any direction against the outboard stop and capable of swinging a 15,000 lb load 90°. U-frame should be 10 ft wide by 12 ft high clear inside. Located on starboard hull, aft.

4. BT winch and trolley gate boom.

5. Loading crane rated at 25,000 lbs at 10 ft radius and 4,275 lbs at 48 ft radius, capable of topping 60° and hydraulic extension, similar to Austin-Western Model 410-RP. Hook winch should be capable of storing sufficient cable to load ship when boom is topped and reach the keel.

Crane should be provided with an operator's cab which rotates with the boom.

6. Stern handling crane with a 48 ft reach and a load capability of 8,550 lbs at this reach with a 50,000 lb capability at a reach of 15 ft when resting on a stop 6 ft from the center of rotation. Adjustable or removable stop should be provided for seating the boom flat out or depressed 30°. Crane should be capable of topping to 45° and depressing to 30°. Should be hydraulically extensible and equipped with 30 in. diameter sheaves for handling of equipment as shown in our drawings of the handling gear. Sheaves should be located so that load does not raise or fall when the crane is trained. No cab is required, but a control stand at some distance is required. (This may be in the same cab as after cab of winch item B-1.)

C. Midship Equipment

1. 25-ton capacity traveling crane. Athwartship motion sufficient. Athwartship carriage should be capable of 25-ton downward pull or athwartship pull. The traveling structure should be so configured as to provide an outreach over each side to provide overboarding sheave points for various winches.

2. One dual drum hydraulically operated auxiliary winch similar to the auxiliary winches specified for bow and stern. This winch also requires its own power pack and control cab with view of stowage drums below. It will serve both as an auxiliary winch and a hydrographic winch. One drum should be provided with a removable barrel for providing a larger diameter for hydrographic wire in order to obtain high line speed. This particular drum should be equipped with 30,000 ft of 7 x 7 galvanized hydro wire, 3/16 in. diameter. The other drum should be equipped with 20,000 ft. of 4-conductor armored cable.

3. One hydraulically operated U-frame to service the above winch and a platform. U-frame should be capable of handling a 20,000 lb load in any direction when against the outboard stops and should be capable of transiting a 10,000 lb load 90°. U-frame dimensions identical to that specified for stern unit.

D. Other Handling Equipment

1. A cable well capable of storing 30 miles of 1 in. diameter cable is important. It could be a portable arrangement and could be mounted in the midship well area. The power for hauling cable in and paying it out will be provided by the stern area traction winch. However, a back tensioning arrangement or braking arrangement is necessary. Presumably, this can be provided by such a company as Western Gear utilizing one of the power packs already installed.

E. General Comments

1. Wherever possible, we would like to place the winch stowage drums below decks to protect the rope and cable. The operator should be provided with a closed control cab at each winch location as already noted.

2. All winches should be equipped with tensiometers. Line speed indications and footage information should be provided. Provisions should be made for recording anchoring tension, relative wind direction, wind velocity, and ship's orientation whether anchoring from the bow or the stern.

3. Item 12 (i) of the SCB Characteristics. In place of sea chests, we would prefer four standpipes, approximately 24 in. diameter from

the main deck down, located as shown on our prints. In our recent meeting, we indicated two of these forward of the forward bridge structure and two in the center well area. We would prefer, because of the presence of handling gear, to put two just aft of the forward deckhouse and two aft of the after deckhouse.

4. Underwater telephone (UQC) should be compatible with communications requirements of both submarines and deep submersibles.

5. High pressure air requirements for the laboratory. At the SCB meeting, we stated that we required 5,000 psi air and quoted a very very small air stowage capacity. In lieu of this, we would prefer a 3,000 psi compressor with a 15 CFM of free air capacity. We would like high pressure air stowage of about 1500 cubic feet of free air at 3,000 psi.

APPENDIX E

(As Revised March 5, 1968)

APPROVED CATAMARAN CHARACTERISTICS

MARCH 15, 1967

1. Mission

To conduct oceanographic research, on a mobile platform, under the direction of designated private and university laboratories supported by the Office of Naval Research, and for naval laboratories under the sponsorship of the Oceanographer.

2. Designed Tasks

(a) To support multi-discipline oceanographic research involving collection, observation and experimentation.

(b) To support limited data processing of materials and data at sea, from fringe ice to tropical regions.

3. Contingent Tasks

As developed

4. General Discussion of Design

(a) The design shall provide a ship with a high degree of seakeeping capability consistent with the size of the ship, a high degree of direction keeping ability and maneuverability at slow speeds, maximum reliability and the most practicable obtainable quietness when not using the diesel main propulsion plant.

(b) The design should provide for the optimum arrangement of facilities for the collection, observation and experimentation of oceanographic data. Adequate open deck areas forward and aft to support multi-discipline oceanographic experiments shall be provided.

(c) The ship shall be capable of self-support on independent operations for extended periods of time with minimum logistic support from U. S. sources.

(d) In designing the machinery installations, particular attention shall be paid to the use of acoustic silencing techniques to obtain the lowest practicable ships radiated noise level.

(e) The ship, its machinery and outfitting shall meet the requirements of the American Bureau of Shipping, MSTS, the United States Coast Guard, the U. S. Public Health Service and the Federal Communications Commission.

(f) Provision shall be made for minimum operational crew and minimum maintenance. Automated features shall be incorporated to the maximum extent practicable.

5. Hull Characteristics

(a) Approximate dimensions and displacement:

(1) Length overall - 246 feet

(2) Beam, maximum - 80 feet

Each hull 24 feet

Distance between hulls 32 feet

(3) Draft, navigational - 21 feet

(4) Displacement, full load - 3000 tons

(b) Subdivision: A two compartment standard is required (Note 1).

(c) Seaworthiness and maneuverability: A high degree of directional control, maneuverability and seakeeping qualities at very low speeds are desired.

(d) Damage control: Damage control features in accordance with United States Coast Guard and MSTS Class II requirements.

(e) Class C ice-strengthening in accordance with American Bureau of Shipping regulations.

(f) A future growth margin of 50 tons at the main deck level shall be provided.

(g) The trailing edge of the rudder shall be located at least 10 feet forward of the stern.

6. Special Features

(a) The following facilities shall be provided:

(1) Oceanographic laboratories adequate for the collection and immediate processing of oceanographic samples and data.

(2) Research control center adequate for the installation and operation of oceanographic sensors and recorders, and the immediate recording and plotting of oceanographic data.

(3) An electronic recorder room for the centralized recording of data sensors.

(4) Photographic processing facilities.

(5) Calibration and instrument test facilities.

(6) Scientific office space or library.

(7) Scientific chill and freeze rooms of approximately 250 cubic feet each. Chill room convertible to freeze.

(8) Gravity meter room.

(b) Scientific stowage space for scientific equipments and supplies and oceanographic samples.

(c) Stowage designed for approximately 20 tons of explosives to meet U. S. Coast Guard regulations with topside stowage for approximately 300 cubic feet.

(d) Winches, cranes, davits and "U" frame foundations for scientific use.

7. Armament

None

8. Communications and Electronics

(a) Communications and electronics equipment shall be provided to meet the requirements of the Electronics Requirements Plan.

(b) Naval Ship Systems Command shall submit an Electronics Equipment List for approval by the Chief of Naval Operations.

(c) Standard visual signal facilities.

9. Propulsion and Engineering Features

(a) Speed: Sustained speed of 15 knots.

(b) Endurance: 6000 miles at 13.5 knots

(c) Power plant: Twin screw diesel propulsion plant with bridge control shall be provided.

(d) A central remote control and monitoring station shall be provided.

(e) Electrical plant:

(1) Ship's service: The ship's service generators shall be multiple units of sufficient capacity so that in the event of derangement of one unit, the remaining unit(s) can carry the normal operating load.

(2) A separate generator and distribution system for scientific instrumentation of approximately 100 K.W.

(f) Distilling plant: Evaporators shall be provided in multiple units with sufficient capacity to provide 60 gallons per man per day in accordance with the accommodations listed in paragraph 13 plus that required for hydrographic and oceanographic use.

(g) Potable water stowage: Stowage shall be provided for not less than 120 gallons per man for the accommodations listed in paragraph 13.

10. Protection

None

11. Aviation Features

None

12. Command and Ship Control

(a) Bridge:

(1) A Navigational Bridge and Pilot House with automatic course control equipment. Bridge wings will extend the width of the ship.

(b) A Chart House located on the same level and aft the bridge.

(c) An Auxiliary Control Station located aft.

13. Accommodations, Berthing, Messing, Sanitation and Medical

(a) Accommodations:

	OFF	CIV TECH	CPO	OTHER ENL	TOTAL ENL
Crew (Civilian)	11		3	30	33
Scientific personnel		25			
Total	11	25	3	30	33

In addition, emergency berthing for (5) scientific personnel will be provided. No change in present messing, sanitation, medical or provisioning characteristics is necessary for these emergency accommodations.

(b) Messing: Two messes shall be provided in accordance with usual practice on civilian manned ships.

(c) Sanitation: Sanitation facilities in accordance with standard regulations of the U. S. Public Health Service and U. S. Coast Guard.

(d) Air conditioning: The living, messing, laboratory and office spaces shall be air conditioned.

(e) Merchant Marine habitability standards in accordance with usual practice on civilian manned ships.

(f) Sewage retention and treatment tanks shall be provided. All overboard discharges, where feasible, shall be to the outboard sides.

(g) Medical facilities in accordance with U. S. Coast Guard regulations.

14. Provisions and Stores

(a) Stowage space for consumable stores based on the total accommodations shown above shall be provided as follows:

	Days Endurance
Dry provisions*	90
Frozen provisions*	90
Chilled provisions*	45
General Stores Material	60
Medical Stores	120

*This requires that stowage space for 90 days subsistence endurance without replenishment shall be provided including refrigerated facilities for a minimum stowage capacity as indicated. Chill stowage shall be convertible to frozen. Separate boxes for freeze (0°F), chill (35°F), dairy (32°F), fish (0°F) and thaw (38° - 40°F).

(b) Separate stowage space shall be provided for deck, engine and steward stores in accordance with MSTS practice.

15. <u>Miscellaneous</u>

The following shall be provided:

(a) Boats of the following types:

2 - 24-foot U. S. Coast Guard approved Class I life boats stowed in davits.

1 - 16-foot Boston whaler workboat with an outboard motor.

(b) A capability of towing and being towed. A towing machine is not required.

(c) A bonded stores locker and small arms locker.

(d) Shops for routine maintenance.

(e) A capability of deep anchoring by the bow.

(f) Degaussing is not required.

(g) A limited scuba diving capability.

(h) Open deck space for instrument vans or huts.

(i) Three transducer tubes for affixing electronic devices.

(j) Air stowage flasks for 7½ cubic feet of air at 3000 psi.

(k) An integrated telephone and high audio volume intercommunications system capable of a minimum of five simultaneous circuits.

Note 1: Watertight doors in watertight bulkheads below the damage control deck in engineering and laboratory spaces may be installed where required in the interest of reduced manning requirements and mission accomplishment.

ELECTRONICS REQUIREMENT PLAN

1. Infrared Communication Facilities

   None

2. Radio Transmitting Facilities (See Note 1)

   (a) 1 - 405-500 kcs; A1, A2

   (b) 1 - 2-24 mcs, A1

   (c) 1 - 2-9 mcs, A3

   (d) 1 - 405-525 kcs; A2; battery powered

   (e) 1 - 156-162 mcs; F3

3. Radio Receiving Facilities (See Note 1)

   (a) 1 - 100-590 kcs; A1, A2

   (b) 1 - 2-24 mcs; A1

   (c) 1 - 2-9 mcs; A3 (included in 2(c) above)

   (d) 1 - 350-535 kcs; A1, A2; battery powered

   (e) 1 - 2-24 mcs; A1, A3, F4

   (f) 1 - 156-162 mcs; F3 (included in 2(e) above)

4. Terminal Facilities (See Note 1)

   (a) 1 - Facsimile 60/90/120 LPM half duplex receiver

5. Radar Facilities (See Note 1)

   (a) 1 - 10 CM "main" navigational radar

   (b) 1 - 3 CM navigational radar (Locate near Research Control Center)

6. Sonar Facilities (See Note 1)

(a) 1 - Low frequency 3.5KC echo sounder (transducers & cable only)

**(b) 2 - Precision Depth recorders (Dry paper)

(c) 1 - Echo sounder, shallow with recorders

**(d) 1 - Echo sounder, deep, narrow beam

(e) 1 - Underwater telephone

7. Countermeasures Facilities

None

8. Navigational Facilities (See Note 1)

(a) 1 - Loran A

**(b) 1 - Loran C receiver

(c) 1 - Radio Direction Finder (210-520 kcs)

**(d) 1 - Satellite Receiver

9. Radiac Facilities

None

10. Remote Station Facilities

(a) Pilot House

1 - Control and monitoring of 2 voice channels

1 - Radar display/control 10 CM

(b) Chart House

1 - Reception of CW channel

1 - Control of radio direction finder

1 - Control of echo sounder, shallow

1 - Control of Loran A

(c) Research Control Center

**1 - Control of voice channel

1 - Radar display/control 3 CM with Sector Sweep

**1 - Control of Loran C

**1 - Control of echo sounder, deep, narrow beam

1 - Control of underwater telephone

**1 - Control of satellite receiver

(d) Radio Room

1 - Control and monitoring of all ship voice/CW channels

11. Meteorological Facilities

None

12. Supplementary Radio Facilities

None

13. Special Facilities (See Note 1)

(a) 1 - Automatic alarm

(b) 1 - Automatic alarm keyer

**(c) 2 - Remote control of scientific receive channels

**(d) Scientific communications facilities

(1) Radio Transmitting Facilities

(a) 2 - 2-30 mcs; A1, A3, A3J, A9B, F1

(b) 1 - 30-40 mcs; F3

(2) Radio Receiving Facilities

(a) 3 - 2-30 mcs; A1, A3, A3J, A9B, F1

(b) 1 - 30-40 mcs; F3 (included in 13(d).(1).(b) above)

(3) <u>Terminal Facilities</u>

(a) 1 - Simplex FSK teletype facility with teletype tape facility

Note 1: Commercial marine equipment approved by NAVSHIPS shall be utilized to fulfill these requirements, whenever possible.

(*) Note 2: Items marked with (*) are not service approved.

(**) Note 3: Items marked with (**) are for scientific requirements only. Space, weight, foundation and cabling only shall be initially installed.

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1 ORIGINATING ACTIVITY (Corporate author) Hudson Laboratories of Columbia University Dobbs Ferry, New York 10522	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP

3 REPORT TITLE

Preliminary Design Considerations for the Catamaran Research Vessel T-AGOR-16

4 DESCRIPTIVE NOTES (Type of report and inclusive dates)

Technical Report

5 AUTHOR(S) (First name, middle initial, last name)

Henry C. Beck and Andrew Gonda

6. REPORT DATE	7a. TOTAL NO OF PAGES	7b. NO. OF REFS
September 1968	197	9

8a. CONTRACT OR GRANT NO. Nonr-266(84) b. PROJECT NO. c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) Technical Report No. 155 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. DISTRIBUTION STATEMENT

Document cleared for public release and sale; its distribution is unlimited

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Office of Naval Research, Code 466

13 ABSTRACT

A history of ship usage at Hudson Laboratories is presented. Experience derived from this usage, from the conversion of the USNS GIBBS to a research vessel, as well as from preliminary plans for the conversion of the USS TERROR to a research vessel, is described as it relates to the preliminary design of the T-AGOR-16. A discussion of the preliminary design of the catamaran research vessel and its equipage is presented and terminates with the development of the building specifications. Originally intended for use by Hudson Laboratories of Columbia University, the subject vessel is now to be used by the Naval Research Laboratories. In discussing its mission, Hudson Laboratories oriented programs are stressed. Changes to be made to the vessel by ~~NRL~~ to accommodate their programs are not detailed.

DD FORM 1473 1 NOV 65 (PAGE 1)

S/N 0101-807-6811

UNCLASSIFIED

Security Classification

A-31408

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
catamaran research vessel						
acoustic research vessel						
scientific handling gear						
scientific electronic equipment						
research vessel laboratory layout						
ship conversion						